MDC's Stormwater Monitoring Network, Blenheim Water Quality Results 2013-14

September 2016

SUSTAINABLE ENVIRONMENTAL ENGINEERING LTD

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Water Quality Results 2013-14

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8 September 2016

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1. INTRODUCTION

SEE Ltd were commissioned by the Marlborough District Council (MDC) to collate and summarise water quality data collected as part of MDC's Blenheim Stormwater Strategy (2012).

The Blenheim Stormwater Strategy was established to provide an inclusive, holistic and prioritised approach to managing Blenheim wide stormwater issues including:

i. Ageing infrastructure;
ii. Integrating urban network and rural drainage channels as complimentary parts of one system;
iii. Accommodating urban growth;
iv. Sensitive, high value waterways – eg; Taylor River, Murphys Creek; and
v. Regulation and compliance

One strand of the strategic effort was to focus specifically on the water quality of the Taylor River downstream of the confluence with Doctors Creek and the springs discharging to the Taylor River.

Figure 1 shows an overview of the rivers, streams and drains within the Blenheim urban catchment.

Figure 1: Overview of study area

A separate but associated MDC survey investigated the effects rural discharges have on the water quality of the Taylor River (Henkel, 2015). The investigation focussed primarily on the Doctors Creek catchment which is one of the main tributaries discharging to the Taylor River and therefore has a significant impact on the overall water quality of the Taylor River. The Doctors Creek catchment is predominately a rural catchment.

Monitoring was carried out over a ten month period beginning on the 27 November 2013 and ending on the 7 August 2014. A total of 31 sites were monitored, comprising of rivers, springs, drains, ephemeral surface waters and outfall pipes. The number of samples taken at each site ranged from 1 to 13. Ten of the sites were sampled during a first flush event, which occurred on the 15 March 2014.

A 'first-flush' event occurs when pollutant concentrations peak early in a storm event, typically before the peak in stormwater flows resulting in a disproportionately greater discharge of pollutant mass relative to the volume discharging during a storm event (Bertrand-Krajewski *et al.*, 1998). Wash-off of pollutants, including first flush, is controlled by physical processes such as rainfall timing, intensity,

and duration. The occurrence of a first flush event during rainfall can be difficult to estimate and is a function of the intensity and duration of the rainfall event, impervious area and antecedent dry weather period.

2. STUDY AREA AND SAMPLE SITES

The urban area of Blenheim is broadly divided into eleven zones based on land use and surface water catchments (Figure 2). These eleven zones fall into two distinct catchment types with the northern zones dominated by spring fed flow and the southern catchments dominated by rainfall generated flow in the Wither Hills and beyond.

Springlands is dominated by two spring fed streams, Murphys Creek and Fultons Creek. Central Blenheim is a mix of commercial and residential areas, whilst Kinross is predominately industrial. The Opawa Loop is predominately residential. The Taylor River and the Opawa River are the predominant catchments in north and central Blenheim and have permanent flow all year round.

The southern area of Blenheim, towards the Wither Hills, consists of catchments which are more ephemeral in nature. They also tend to be slow flowing streams who's catchments are dominated by surface water flows deriving from rainfall in the Wither Hills. The upper Taylor River, as distinct from the lower Taylor River is often dry during the summer months and even beyond (Henkel, 2015).

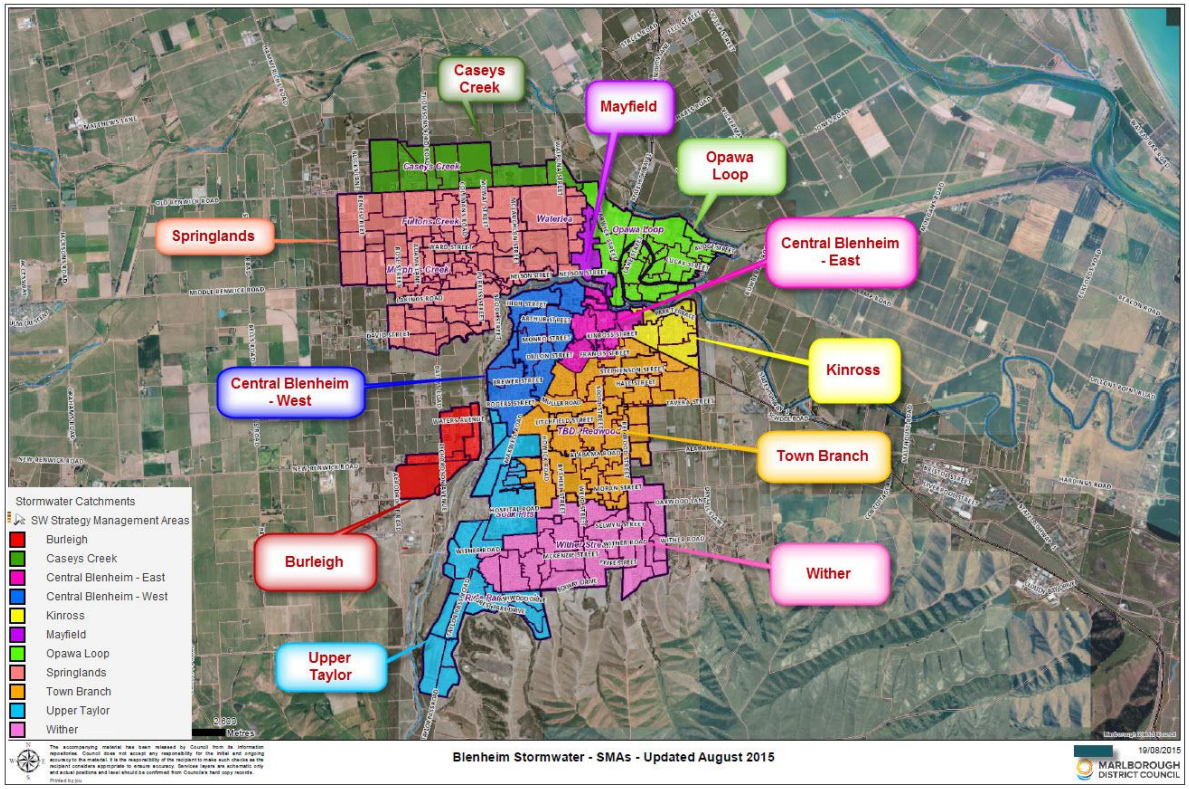

Figure 2: Stormwater catchment zones in Blenheim

A total of 31 sites were samples during this survey. Table 1 describes the sites, including their name as given in MDC's database and their grid reference locations. Site IDs have been attributed by SEE Ltd to the sites for ease of reporting. The site ID consists of the following nomenclature: ST for stormwater survey; DR to denote a drain site; EST to denote an ephemeral stream site; PI to denote a pipe outfall and RIV to denote a river site. The locations of each of the sites along with photos of the sites are shown in Appendix 1. A google image shows the spread of the sites in relation to the town centre (Figure 3).

Table 1: Sites sampled during the stormwater survey and their locations

Site Name[i]	Site ID	Easting (NZTM)	Northing (NZTM)	Latitude	Longitude
Alabama Road Drain	ST_DR_1	1680553	5402192	41 31 40.32069 S	173 57 55.96314 E
Riverlands Coop Drain at RCD-1	ST_DR_2	1681207	5401760	41 31 54.08910 S	173 58 24.39014 E
Riverlands Coop Side Drain 1	ST_DR_3	1681065	5401750	41 31 54.46514 S	173 58 18.26800 E
Riverlands Coop Side Drain 2	ST_DR_4	1680930	5401740	41 31 54.83854 S	173 58 12.44788 E
Town Branch Drain at TBD-1	ST_DR_5	1681699	5402855	41 31 18.40682 S	173 58 45.08347 E
Westmeat Drain into Town Branch Drain	ST_DR_6	1681735	5402848	41 31 18.62055 S	173 58 46.63997 E
Riverlands Coop/Sutherland Stream	ST_DR_7	1680676	5401719	41 31 55.61172 S	173 58 01.49842 E
Sutherland Stream at SUS-1	ST_EST_1	1680391	5400710	41 32 28.42879 S	173 57 49.68685 E
Wither Stream upstream Sutherland Stm	ST_EST_2	1680467	5401571	41 32 00.48593 S	173 57 52.55174 E
Sutherland Stream - Hospital Road	ST_EST_3	1680670	5401610	41 31 59.14790 S	173 58 01.29217 E
Pipe at STW-14	ST_PI_1	1680113	5403936	41 30 43.93541 S	173 57 36.14331 E
Pipe at STW-15	ST_PI_2	1680057	5403944	41 30 43.69619 S	173 57 33.72392 E
Pipe at STW-16	ST_PI_3	1679255	5404251	41 30 34.02969 S	173 56 58.98409 E
Pipe at STW-17	ST_PI_4	1678813	5403564	41 30 56.46085 S	173 56 40.24293 E
Pipe at STW-18	ST_PI_5	1681200	5403783	41 30 48.50191 S	173 58 23.10526 E
Pipe at STW-19	ST_PI_6	1679631	5401037	41 32 18.10037 S	173 57 16.73361 E
Henry St Stormwater	ST_PI_7	1679605	5404320	41 30 31.66761 S	173 57 14.04790 E
Town Branch Pump Station Discharge Pipe	ST_PI_8	1681735	5402847	41 31 18.65297 S	173 58 46.64046 E
Sutherland Stream Brooklyn Pipe	ST_PI_9	1680670	5401690	41 31 56.55414 S	173 58 01.25354 E
Doctors Creek Upstream Taylor	ST_RIV_1	1678420	5403566	41 30 56.53490 S	173 56 23.28892 E
Fultons Creek Upstream at Mogridge Place	ST_RIV_2	1678554	5404783	41 30 17.03000 S	173 56 28.49800 E
Fultons Creek at Nelson Street	ST_RIV_3	1679347	5404379	41 30 29.84685 S	173 57 02.89163 E
Murphys Creek at MUR-2	ST_RIV_4	1677588	5404113	41 30 39.09155 S	173 55 47.14454 E
Murphys Creek at MUR-6	ST_RIV_5	1678879	5404222	41 30 35.10356 S	173 56 42.77962 E
Opawa Loop at OPL-5	ST_RIV_6	1681530	5404574	41 30 22.73537 S	173 58 36.95443 E
Opawa Loop at OPL-6	ST_RIV_7	1680228	5404056	41 30 40.00331 S	173 57 41.04627 E
Opawa River at OPR-50	ST_RIV_8	1681161	5403918	41 30 44.13916 S	173 58 21.35745 E
Opawa River at OPR-51	ST_RIV_9	1681345	5403806	41 30 47.70323 S	173 58 29.34875 E
Taylor River at Rail Bridge	ST_RIV_10	1680148	5403948	41 30 43.53374 S	173 57 37.64729 E
Taylor River at TYR-22	ST_RIV_11	1679586	5404334	41 30 31.22049 S	173 57 13.22172 E
Yelverton Stream Upstream Doctors Creek	ST_RIV_12	1678411	5403652	41 30 53.74975 S	173 56 22.86035 E

[i] As given in MDC's environmental database

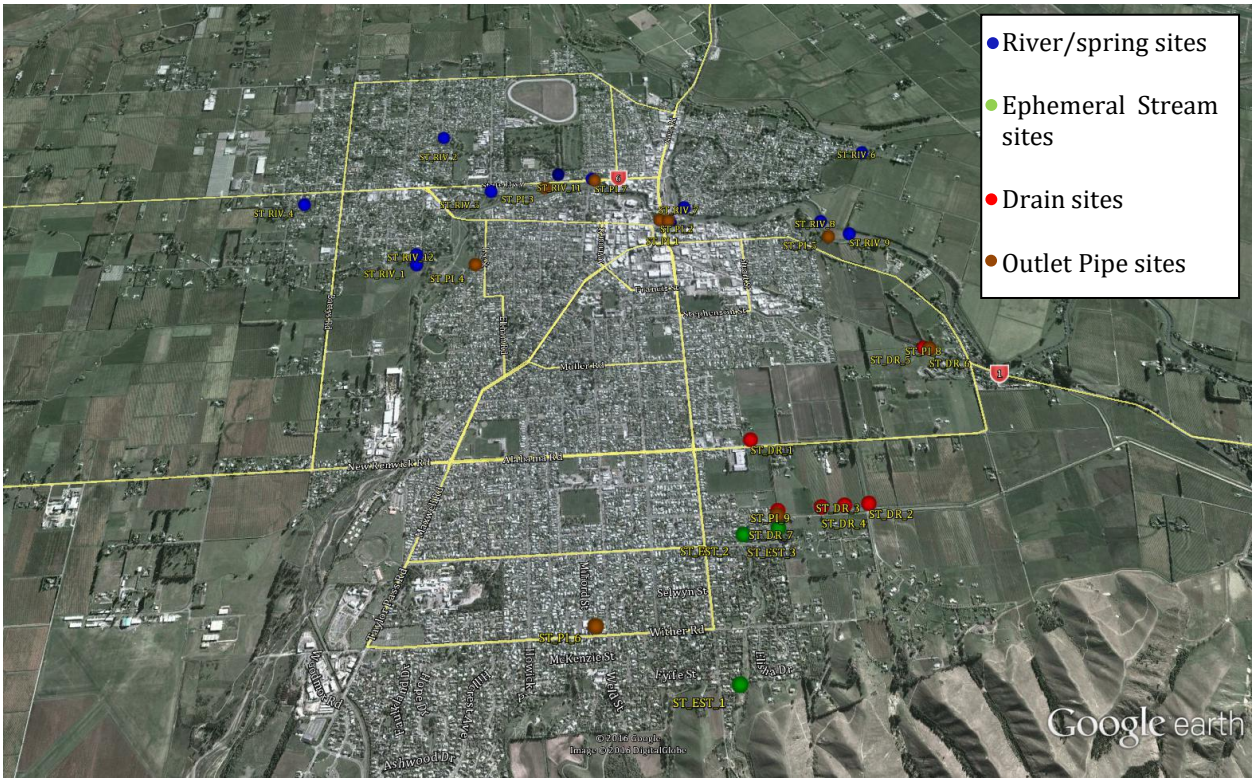

Figure 3: Google image showing the spread of sites sampled during the survey in Blenheim

3. RESULTS

A total of 3,754 results covering 15 different parameters and 31 different sites were collected during the stormwater survey. A general description of water quality from the results from the stormwater survey are given, followed by a description of the nutrient and metal concentrations. This description excludes the results from the first flush event as the these results would skew unnecessarily the results and make it difficult to characterise water quality from each of the sites.

Sample results from the first flush sampling event are discussed separately and compared with the general water quality at each of the sites sampled, thus allowing a comparison of how water quality changes during these rainfall events.

Results are compared with the ANZECC (2000) surface water guidelines and other relevant guidelines (Table 2), this is particularly relevant for the river and spring sites which are particularly important due to their recreational and ecological values. The ANZECC (2000) water quality guidelines outline a decision scheme to determine the most appropriate trigger levels for contaminants in waterways. The different trigger levels define the level of protection attributed to the system i.e. the protection level signifies the percentage of species expected to be protected by that trigger value. In effect the different trigger levels (defined at 99%, 95%, 90% and 80%) represent a continuum of disturbance. These can broadly be described as follows:

99% High conservation/ecological value

95% Slight to moderately disturbed ecosystems

90% Moderately disturbed ecosystems

80% Highly disturbed ecosystems

Table 2: Guideline values used to assess the effects on surface water systems from urban stormwater in Blenheim.

Parameter	Guideline Value	Purpose	Reference
Nitrate	2.4 mg/L	Aquatic ecosystem toxicity (95% protection)	Hickey (2013)
	3.8 mg/L	Aquatic ecosystem toxicity (90% protection)	Hickey (2013)
	0.444 mg/L	Prevent nuisance algal growth in lowland rivers	ANZECC (2000)
	0.167 mg/L	Prevent nuisance algal growth in upland rivers	ANZECC (2000)
DRP	0.01 mg/L	Prevent nuisance algal growth in lowland rivers	ANZECC (2000)
	0.009 mg/L	Prevent nuisance algal growth in upland rivers	ANZECC (2000)
E. coli	550 n/100mL	Contact recreation (action level)	MfE (2003)
	260 n/100mL	Contact recreation (alert level)	MfE (2003)
	126 n/100mL	Contact recreation (median level for surface waters)	McBride *et al.* (1991)
Suspended Solids	10 mg/L	Ecological guideline	CCREM (1991)
Copper	0.0014 mg/L	95% protection	ANZECC (2000)
	0.0018 mg/L	90% protection	ANZECC (2000)
Lead	0.0034 mg/L	95% protection	ANZECC (2000)
	0.0056 mg/L	90% protection	ANZECC (2000)
Zinc	0.008 mg/L	95% protection	ANZECC (2000)
	0.015 mg/L	90% protection	ANZECC (2000)

An exceedance of a guideline does not always imply an effect; rather they are thresholds at which management options need to be considered to prevent further degradation of water quality.

3.1 Summary Statistics

TimeTrends version 5.0 (2014) was used to analyses the available data. All data and site information was supplied by MDC.

3.1.1 General Water Quality

General water quality was assessed by analysing for the following parameters:

- Hardness
- Calcium (dissolved)
- Magnesium (dissolved)
- pH
- *E. coli*
- Total Suspended Solids

The summary statistics for general water quality for each of the sites are shown in Appendix 2.

Water hardness can be simply defined as the amount of dissolved calcium and magnesium present in the water. Hard water is high in dissolved minerals, whilst soft waters are lower in dissolved minerals. Water hardness is categorised in the ANZECC guidelines from soft waters to extremely hard waters as follows:

Hardness category (mg/L as $CaCO_3$)	**Water hardness (mg/L as $CaCO_3$)**
Soft	60
Moderate	90
Hard	150
Very hard	210
Extremely hard	400

The majority of the sites samples can be classed as moderate or soft waters (Figure 4). The hardest waters were observed for ST_DR_5 (Town Branch Drain). Water hardness is known to affect the toxicity of some metals (ANZECC, 2000) e.g. the toxicity of copper and zinc is known to increase with decreasing water hardness (ANZECC, 2000, Kiyani *et al*., 2013).

The pH of the majority of sites can be classed as neutral i.e. between 7-8 (Figure 5). The highest pH was observed for site ST_EST_2 (Wither Stream upstream of Sutherland Stream).

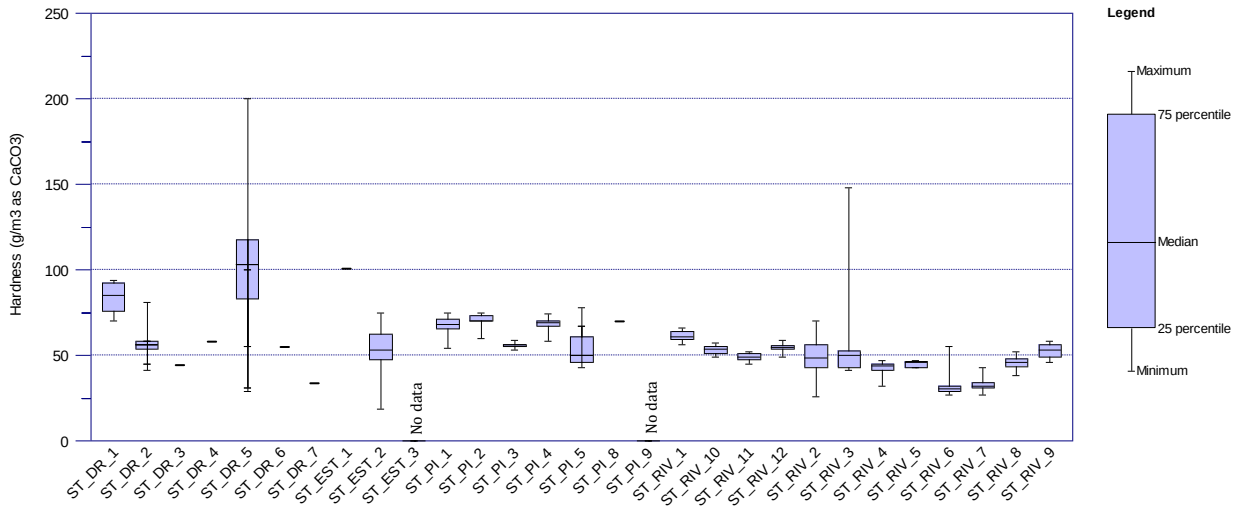

Figure 4: Boxplot showing the summary statistics for water hardness for each of the sites sampled.

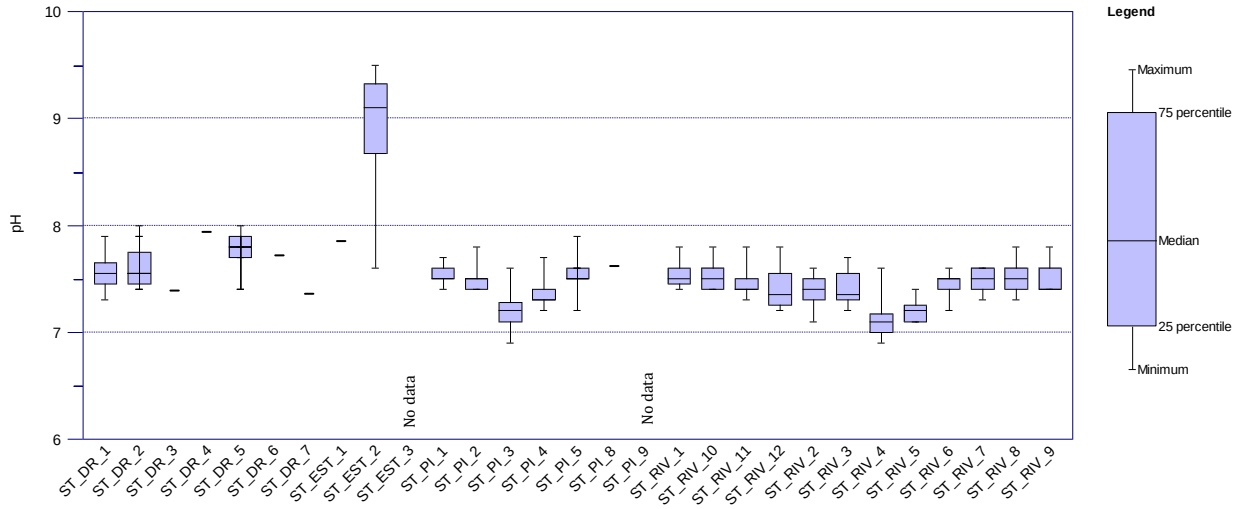

Figure 5: Boxplot showing the summary statistics for pH for each of the sites sampled

E. coli numbers were highest in the drain sites and in the pipe outlet sites respectively (Figure 6). The highest median *E. coli* number was at site ST_DR_5 (Town Branch Drain). The highest maximum numbers were measured from the pipe outlets (Figure 7). The pipe outlets ST_PI_1, which discharges to the Taylor River just upstream of the Opawa River confluence and ST_PI_4, which discharges to a short drain, Chinamans Drain, before discharging to the Taylor River at Monro Street, recorded the highest *E. coli* numbers (38,000 cfu/100mL).

Of the river and spring sites, the sites on Murphys Creek and on the Opawa Loop had the lowest overall *E. coli* numbers. The highest overall *E. coli* numbers from the river and spring sites were recorded at site ST_RIV_12, on Yelverton Stream, the second highest were from ST_RIV_1, on Doctors Creek (Figure 6).

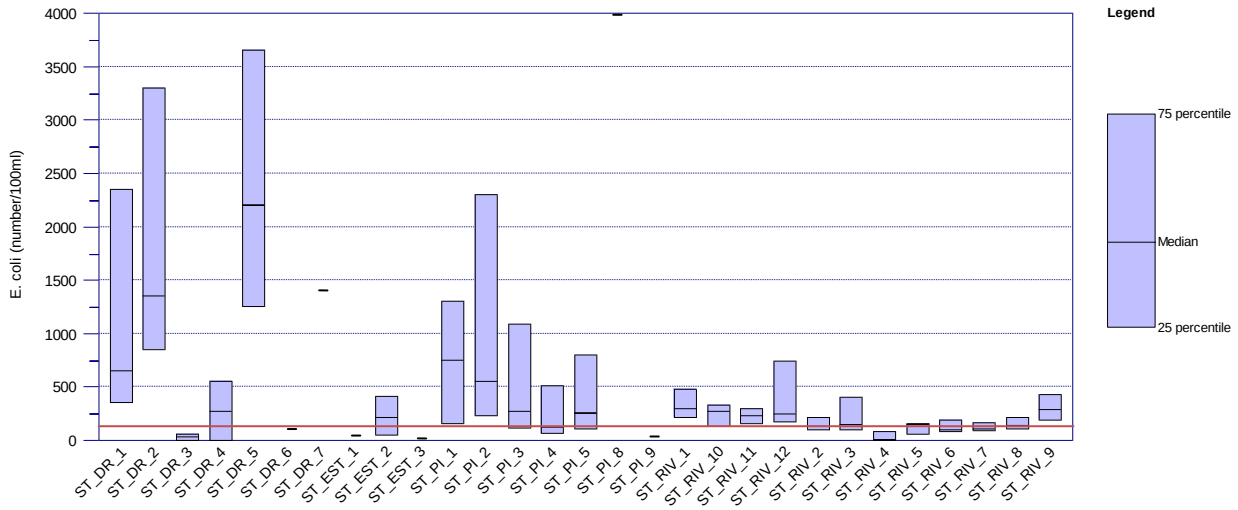

Figure 6: Boxplot showing the summary statistics for *E. coli* for each of the sites sampled. The red line depicts the guideline for the median *E. coli* number for contact recreation (126 n/100mL).

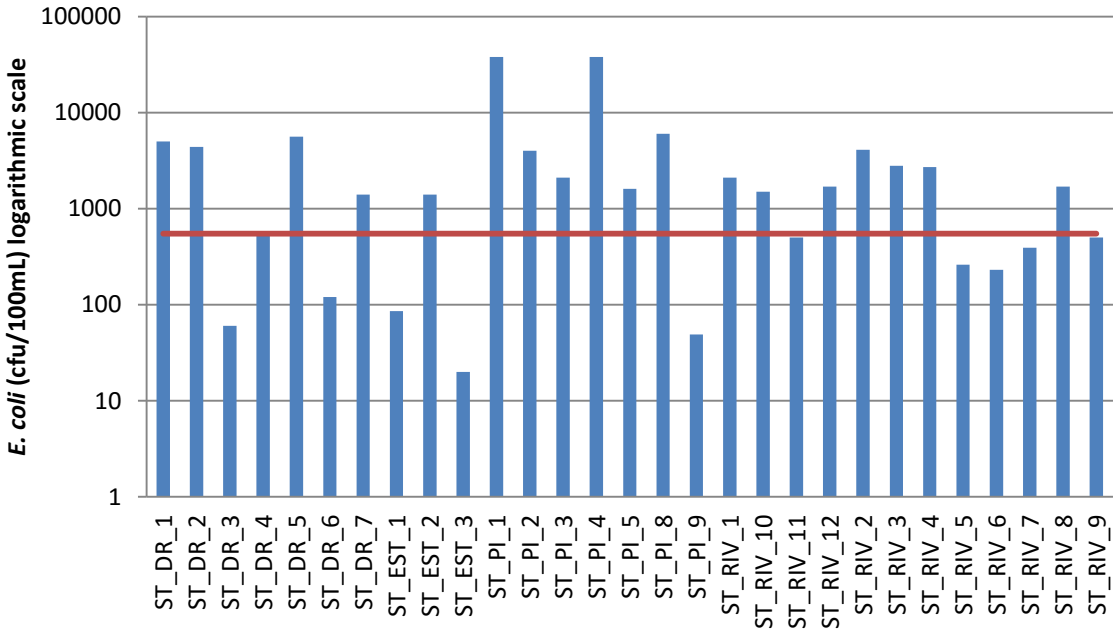

Figure 7: The maximum *E. coli* number recorded for each of the sites shown on a logarithmic scale. The red line depicts the action level contact recreation water guideline (550 n/100mL).

The drain sites ST_DR_2 and ST_DR_5, located on Riverlands Co-op Drain and Town Branch Drain respectively and the river site ST_RIV_9, located on the Opawa River have the highest suspended solids concentrations (Figure 8). The remaining sites have generally relatively low concentrations of suspended solids. Of the discharge pipe sites, ST_PI_1 and ST_PI_5 have the highest suspended solids concentrations. ST_PI_5 discharges upstream of ST_RIV_9, however it is not clear whether this discharge is significantly impacting on the suspended solids concentrations downstream in the Opawa River (Figure 9). Council field notes for the site state *'ST_RIV_9 is not sampled far enough downstream of ST_PI_5 to allow for reasonable mixing and results should be treated with caution*'. It is possible that

the discharge does at times influence water quality downstream but the degree to which it influences is unknown due to the poor location of the downstream sampling point.

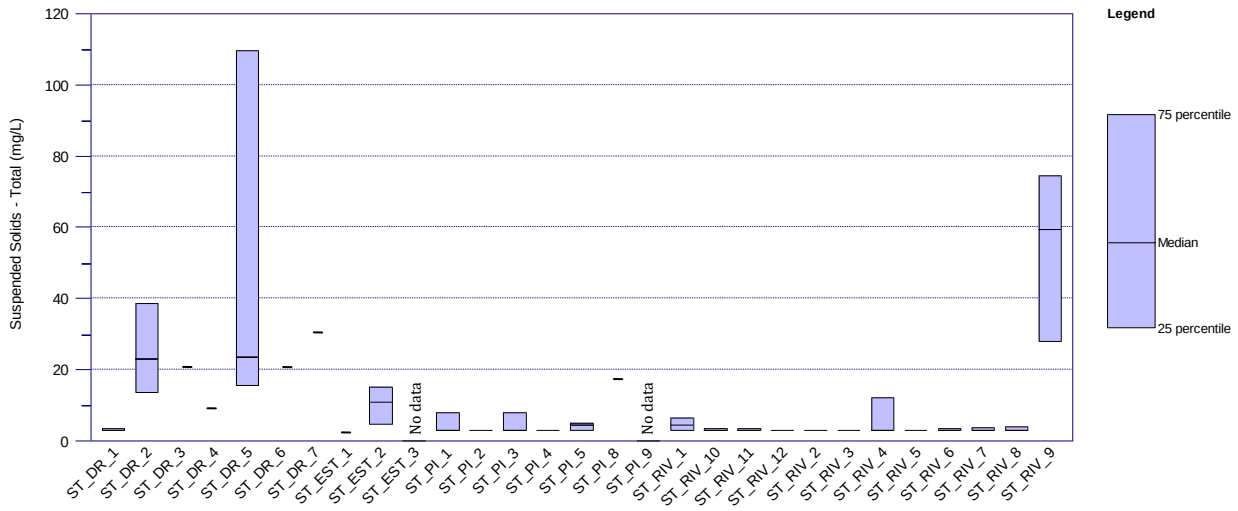

Figure 8: Boxplot showing the summary statistics for Suspended Solids for each of the sites sampled

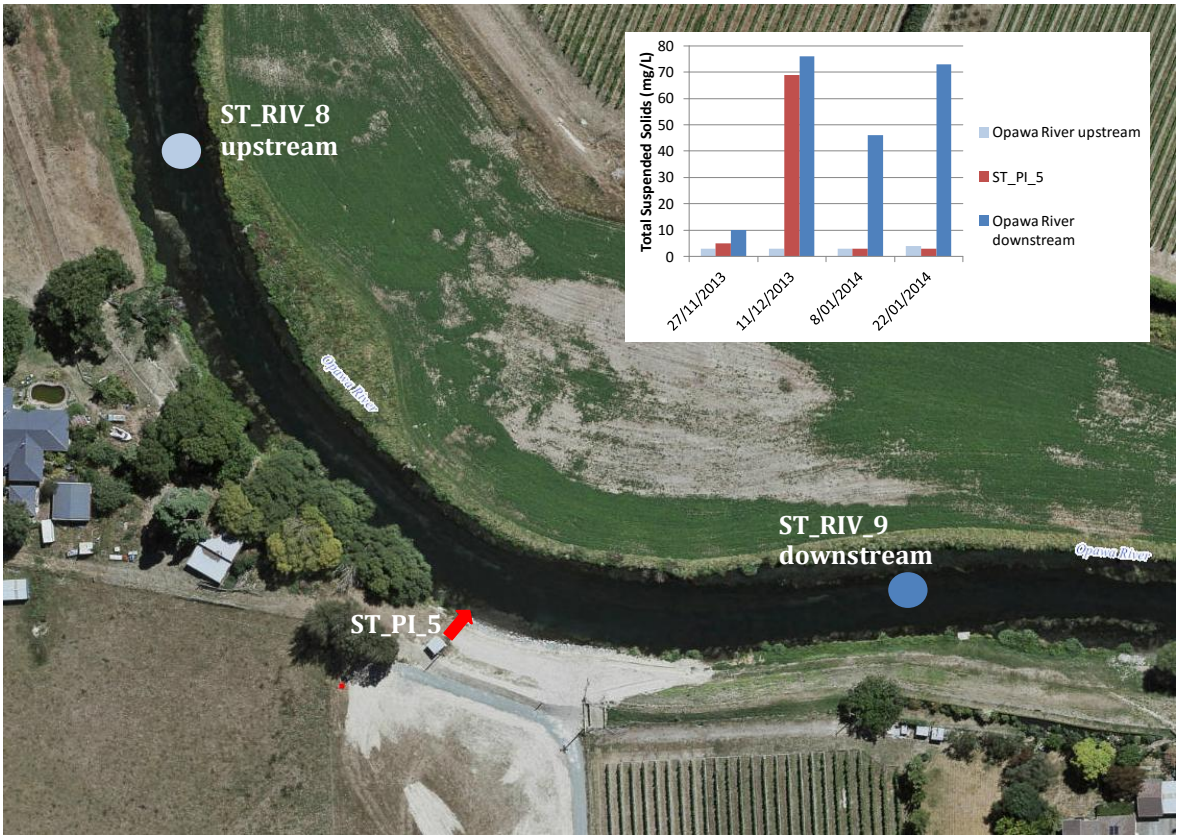

Figure 9: Aerial photo showing the locations of the sites on the Opawa River and the stormwater discharge point. Total Suspended Solids concentrations for the sites are shown in the embedded graph.

3.1.2 Nutrients

Water quality, with respect to nutrient concentrations, was assessed by analysing for the following parameters:

- Nitrate - Nitrogen (mg/L)
- Nitrite - Nitrogen (g/m^3)
- Nitrite - Nitrate Nitrogen (g/m^3)
- Total Nitrogen (g/m^3)
- Dissolved Reactive Phosphorus (mg/L)
- Total Phosphorus (g/m^3)

The summary statistics for each of the nutrients analysed for, at each of the sites are shown in Appendix 3.

With the exception of site ST_DR_1, Alabama Road Drain, and ST_DR_2, Riverlands Co-op Drain, nitrate concentrations for all of the sites, including the drains and pipe sites, are generally below the aquatic ecosystem toxicity guideline for the protection of 95% of species (2.4 mg/L). Nitrate concentrations for the Alabama Road Drain site are generally below the aquatic ecosystem toxicity guideline for the protection of 90% of species (3.8 mg/L) (Figure 10).

Nitrate concentrations generally exceed the guideline value to prevent nuisance algal growth (0.444mg/L) in the river and spring sites. The exceptions are the Opawa Loop sites (ST_RIV_6 and ST_RIV_7), which have the lowest nitrate concentrations of all of the sites.

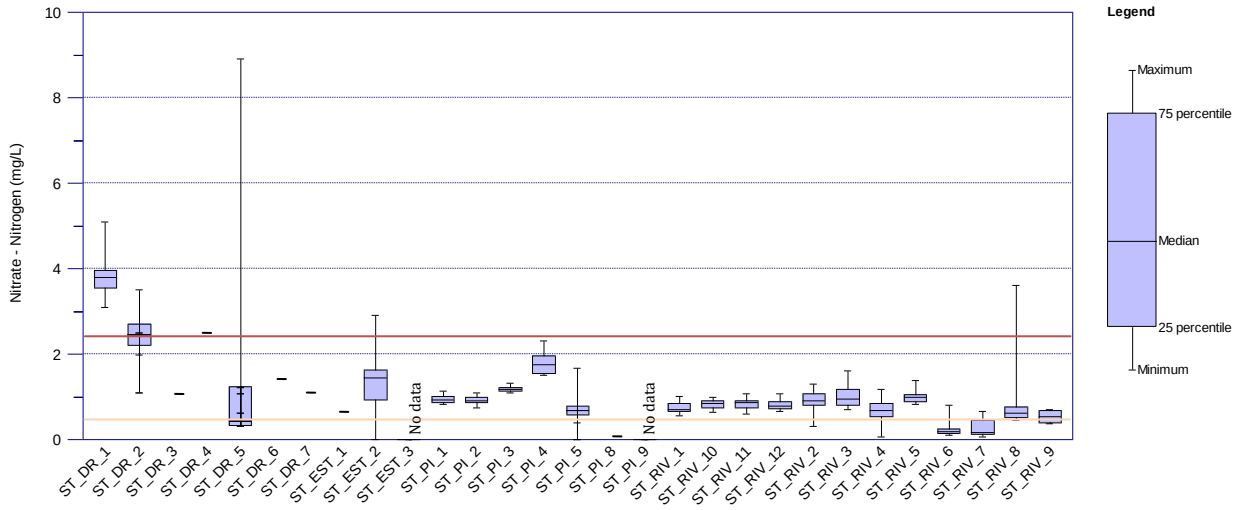

Figure 10: Boxplot showing the summary statistics for nitrate concentrations for each of the sites sampled. The red lines denotes the aquatic ecosystem toxicity guideline for 95% species protection and the amber line denotes the guideline to prevent nuisance algal growth in lowland rivers.

Dissolved reactive phosphorus concentrations exceed the guideline value to prevent nuisance algal growth at all of the sites. Site ST_RIV_6 (the Opawa Loop) has the lowest dissolved reactive phosphorus concentrations and has concentrations that are less than the guideline for 75% of the time.

The highest reactive phosphorus concentration (1.07 mg/L), by a large margin, was recorded from one sample from the discharge pipe ST_PI_8, the Town Branch Pump Station discharge pipe (Figure 11).

Only one sample was ever taken from this site so it is unknown whether this is an exceptional result or whether dissolved reactive phosphorus concentrations are routinely high at this site.

The next highest dissolved reactive phosphorus concentrations are at ST_DR_5 (Town Branch Drain), ST_EST_2, the Wither Stream upstream of Sutherland Stream and the discharge pipe ST_PI_5, which discharges to the Opawa River (Figure 9). It is likely that the discharge from the Town Branch Pump Station discharge pipe is having a significant effect on dissolved reactive phosphorus concentrations in the Town Branch Drain.

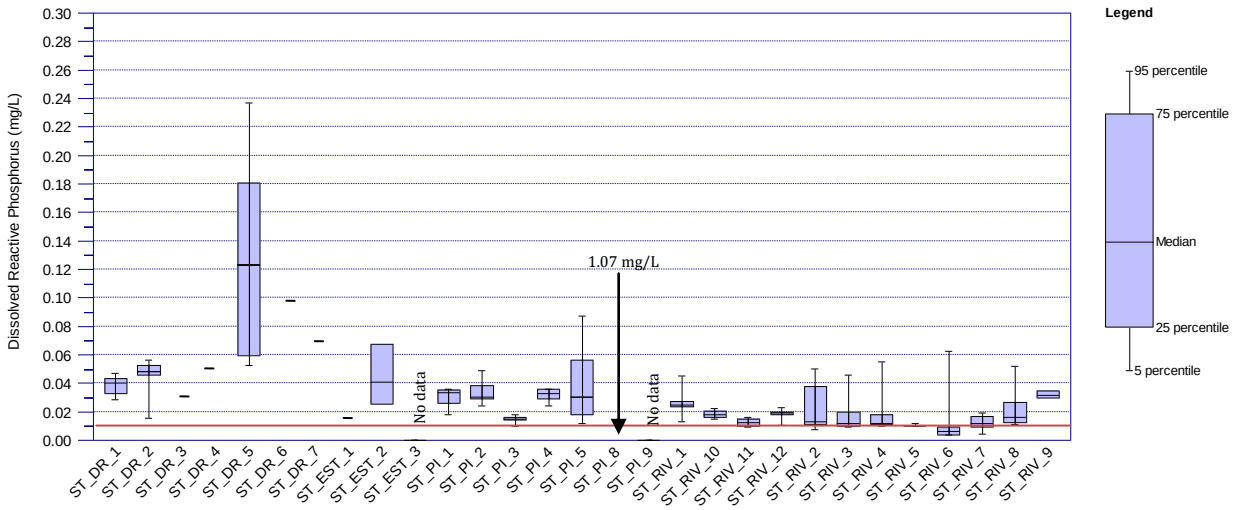

Figure 11: Boxplot showing the summary statistics for dissolved reactive phosphorus concentrations for each of the sites sampled. The red lines denotes the guideline to prevent nuisance algal growth in lowland rivers.

3.1.3 Metals

Water quality, with respect to metal concentrations, was assessed by analysing for the following parameters:

- Copper - Total (g/m^3)
- Lead - Total (g/m^3)
- Zinc - Total (g/m^3)

The summary statistics for each of the metals analysed for, at each of the sites are shown in Appendix 4.

Copper concentrations were below the relevant guidelines for most of the time at all of the river and spring sites with the exception of ST_RIV_9, the lower Opawa site (Figure 12). Whilst lead concentrations were below the relevant guidelines for all of the river and spring sites, the concentrations were elevated at ST_RIV_9, the lower Opawa River site (Figure 13). Zinc concentrations exceeded the ANZECC guidelines at ST_RIV_2, ST_RIV_3, ST_RIV_8, ST_RIV_9, ST_RIV_10 (Fultons Creek, Opawa River and Taylor River at the Rail Bridge) (Figure 14).

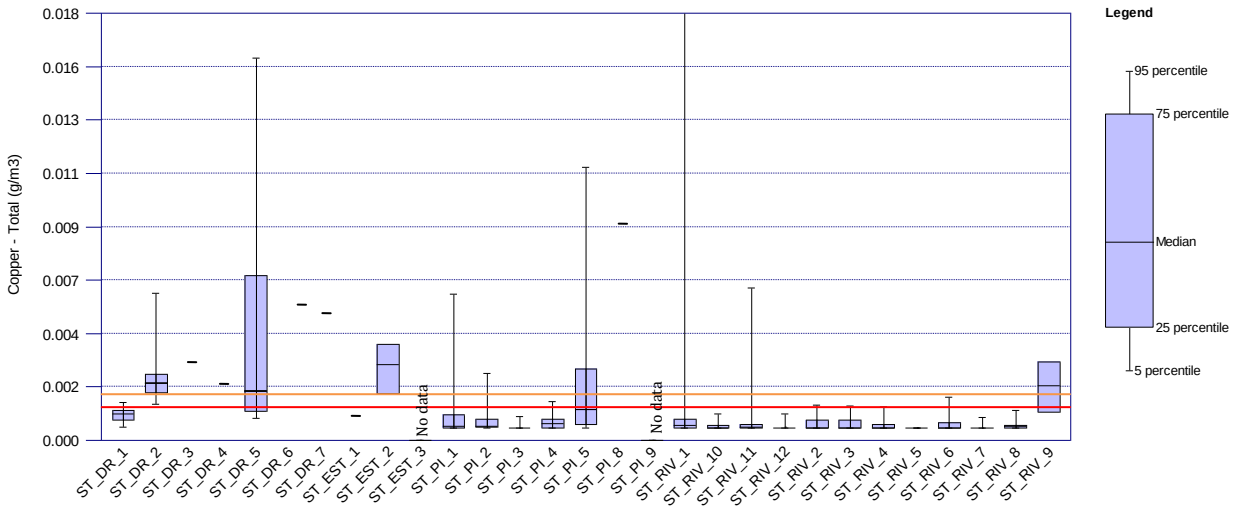

Figure 12: Boxplot showing the summary statistics for copper concentrations for each of the sites sampled. The red lines denotes the aquatic ecosystem toxicity guideline for 95% species protection and the amber line denotes the aquatic ecosystem toxicity guideline for 90% species protection.

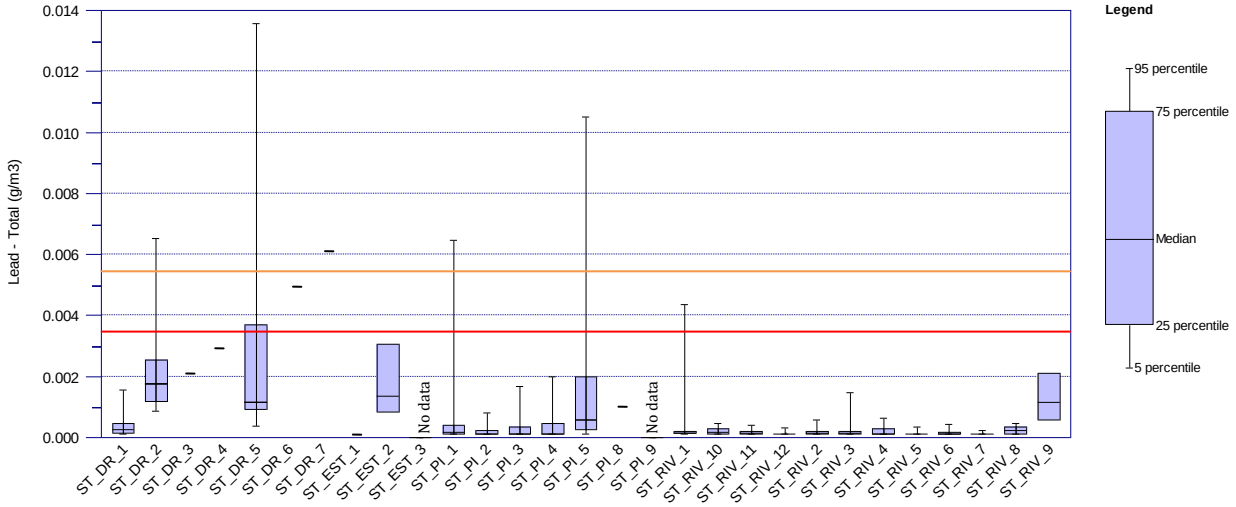

Figure 13: Boxplot showing the summary statistics for lead concentrations for each of the sites sampled. The red lines denotes the aquatic ecosystem toxicity guideline for 95% species protection and the amber line denotes the aquatic ecosystem toxicity guideline for 90% species protection.

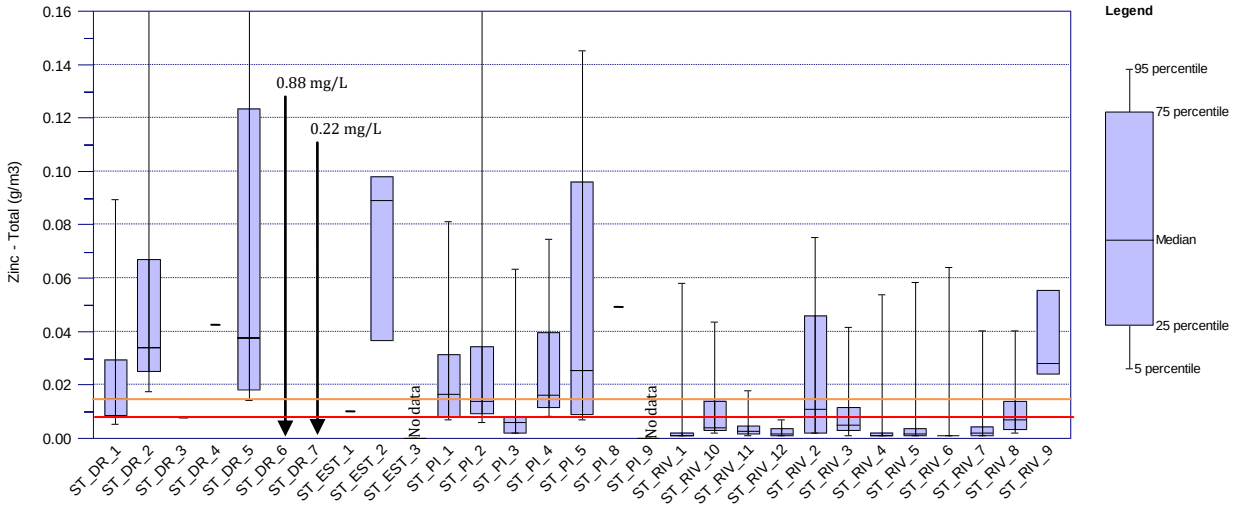

Figure 14: Boxplot showing the summary statistics for zinc concentrations for each of the sites sampled. The red lines denotes the aquatic ecosystem toxicity guideline for 95% species protection and the amber line denotes the aquatic ecosystem toxicity guideline for 90% species protection.

The upstream site on Fultons Creek (ST_RIV_2) has higher zinc concentrations than the downstream site at Nelson Street Sites (ST_RIV_3). This difference is likely due to increased stream flows at the downstream site thus more dilution and also because there is very little extra stormwater discharging to the Creek between these two sites, with the Creek flowing predominately through parkland (Figure 15).

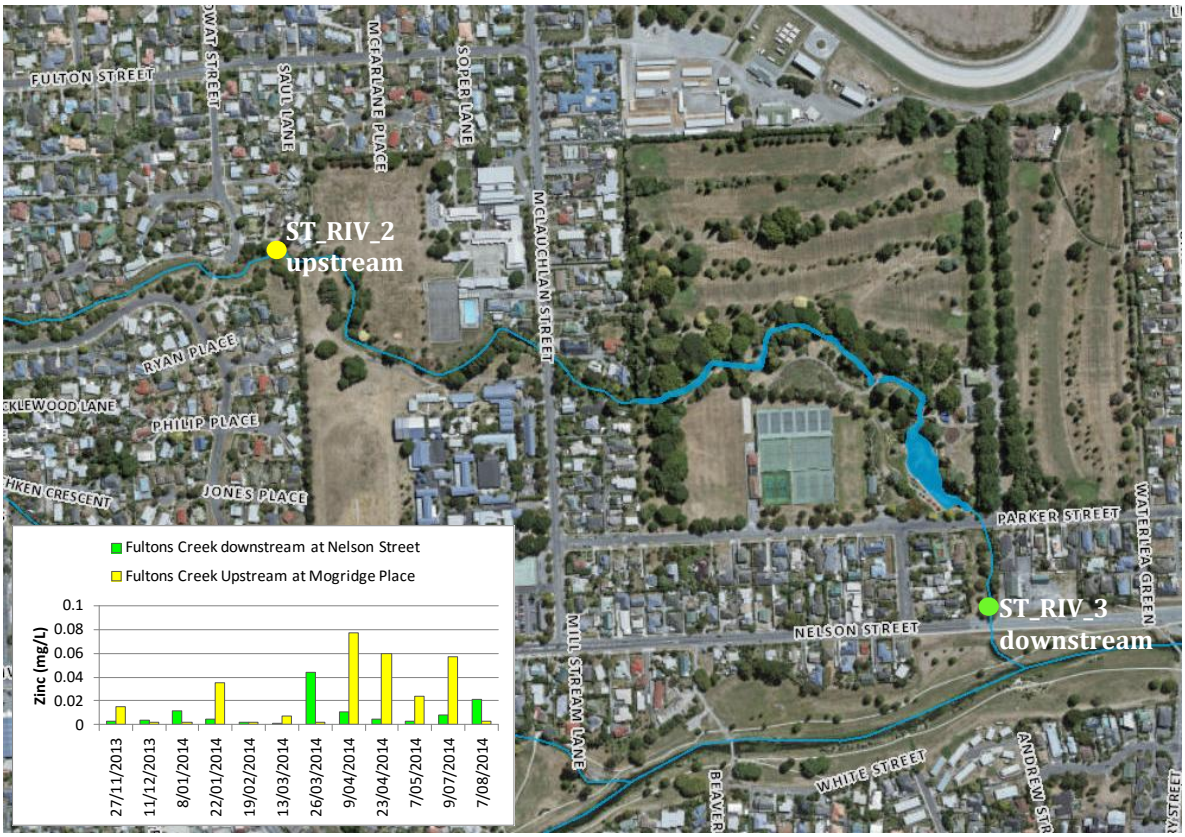

Figure 15: Aerial photo showing the locations of the sites on Fultons Creek. Zinc concentrations for the sites are shown in the embedded graph.

Water quality, with regard to zinc concentrations, at the Taylor River site at the Rail Bridge (ST_RIV_10) is being adversely impacted by the stormwater discharges ST_PI_1 and ST_PI_2. This is apparent when water quality is compared with the upstream site on the Taylor River at Henry Street (ST_RIV_11). Figure 16 shows how these stormwater discharges are resulting in increased zinc concentrations at the downstream site.

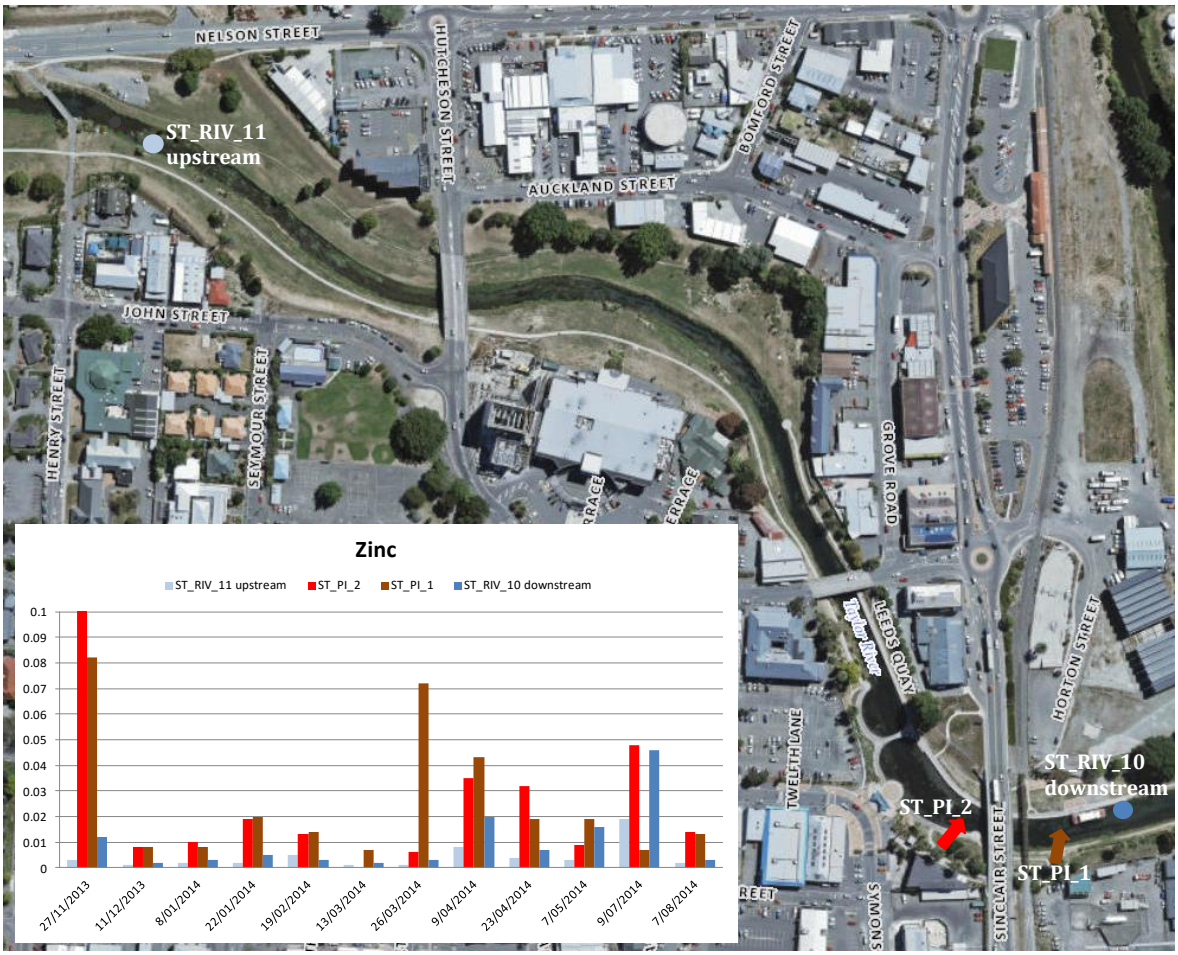

Figure 16: Aerial photo showing the locations of the sites on the Taylor River and the various stormwater discharge points. Zinc concentrations for the sites are shown in the embedded graph.

Water quality for the Opawa River at ST_RIV_9, located downstream of all the discharges and river and stream sites for the northern part of Blenheim is poor in relation to metal concentrations. Metal concentrations are significantly elevated at this site in comparison to all of the other river and spring sites. It is likely that the stormwater discharge at ST_PI_5 is having an impact on the metal concentrations at this site, however Council field notes for the site (ST_RIV_9) state *'ST_RIV_9 is not sampled far enough downstream of ST_PI_5 to allow for reasonable mixing and results should be treated with caution*'. Figures 17 shows the locations of the Opawa River sites and the stormwater discharge at ST_PI_5 and Figure 18 shows the metal concentrations recorded at each of the sites.

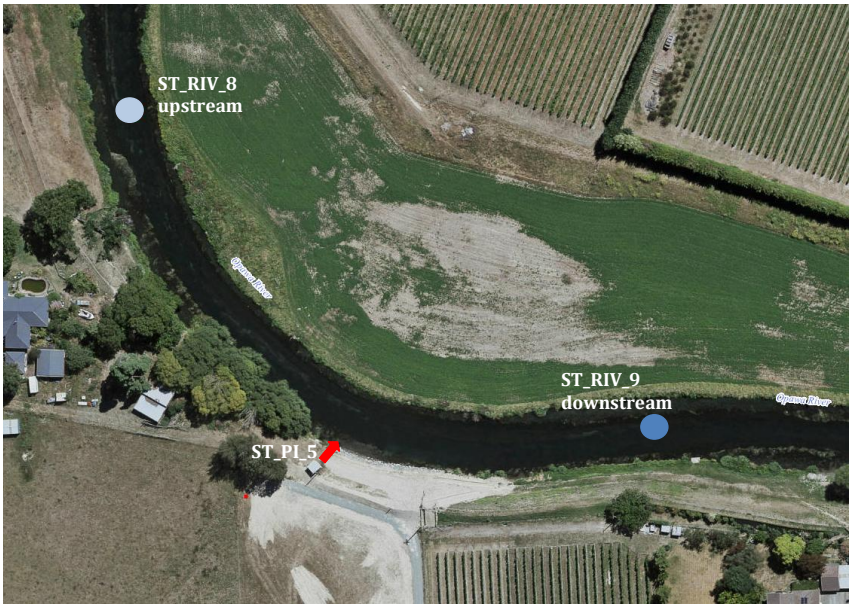

Figure 17: Aerial photo showing the locations of the sites on the Opawa River and the stormwater discharge point.

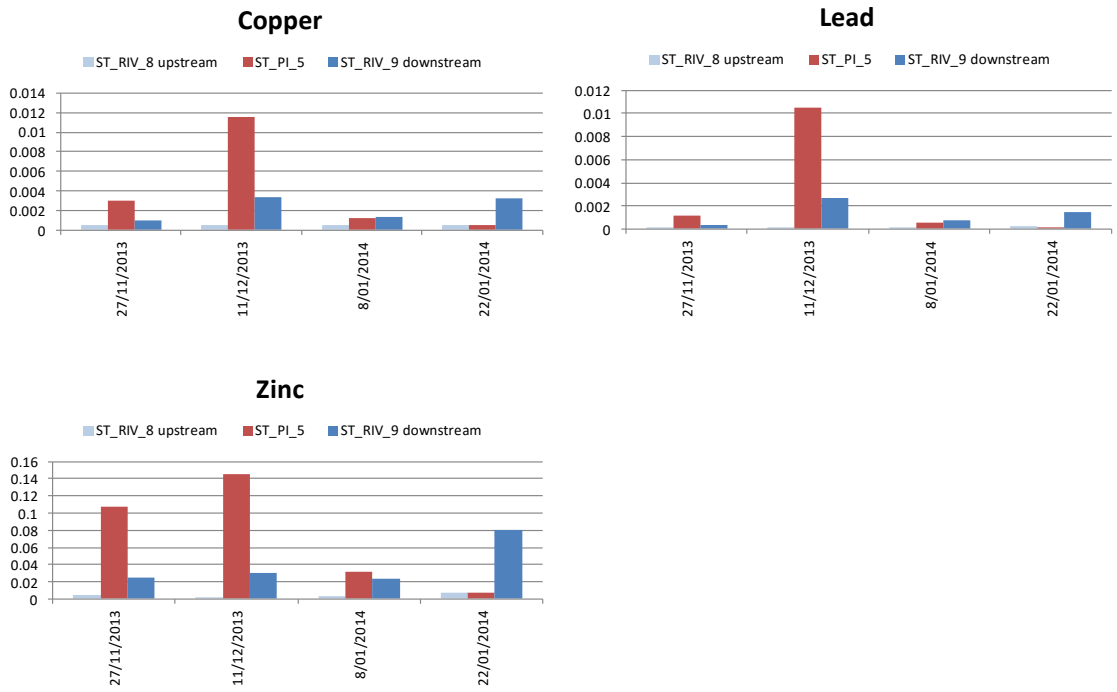

Figure 18: Metal concentrations for the two lower Opawa sites and the stormwater discharge as depicted in the aerial photo in Figure 17.

3.1.4 Organic Compounds

Total petroleum hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH) and a comprehensive suite of pesticides (OrganoNitrogen/Phosphorus and Organochlorines) were analysed for on two occasions (11 December 2013 and 9 July 2014) at five sites. Table 3 shows the sites sampled and the analysis undertaken. The full Hill Laboratories report are presented in Appendix 5.

All of the results were below the limit of detection with the exception of pyrene, which had a concentration of 0.009 µg/L, just above the limit of detection (0.008 µg/L). This was measured from the stormwater pipe ST_PI_2 on the 9 July 2014.

From the results to date it is unlikely that urban stormwater discharges are having an adverse impact on water quality in the rivers and springs in Marlborough with regard to petroleum hydrocarbons and pesticides. However analysis of organic compounds during a first flush event is recommended.

Table 3: Sites sampled for organic compounds

Site	Description	TPH/PAH	Pesticides	Date
ST_PI_2	Stormwater pipe discharging to the Taylor River upstream of the Rail Bridge	✓	✓	11 December 2013 9 July 2014
ST_RIV_10	Taylor River at the Rail Bridge	✓	✓ ✓	11 December 2013 9 July 2014
ST_RIV_11	Taylor River downstream of Henry Street	✓	✓	11 December 2013 9 July 2014
ST_RIV_8	Opawa River at corner of Lybster Street and Park Terrace	✓	✓	11 December 2013 9 July 2014
ST_RIV_9	Opawa River downstream of ST_RIV_8 and a stormwater discharge at St Andrews	✓	✓	11 December 2013 9 July 2014

3.2 First Flush Event

Sampling was carried out on the 15 March 2014 during a rainfall event. Sampling was carried out between 9.25pm and 11pm local time. The full Hill Laboratories results are attached in Appendix 6. Council field notes describe the day as cloudy and raining. Field notes describe *'Lots of debris'* at the stormwater outlet at ST_PI_1, which discharges into the Taylor River just downstream of the Rail Bridge. Figures 19 and 20 show the hourly rainfall for the 15 March 2014 and for the two weeks preceding the sampling. The graphs show that there had only been 1mm of rainfall for the two weeks prior to sampling, however 6mm fell in the hours prior to the sampling. The effects from first flush events are notoriously difficult to assess and depend on a number of factors.

The locations of the sites sampled are shown in Figure 21. A table of results, comparing the median value of each parameter analysed for at each site, with the results from the first flush sampling event, is attached in Appendix 7.

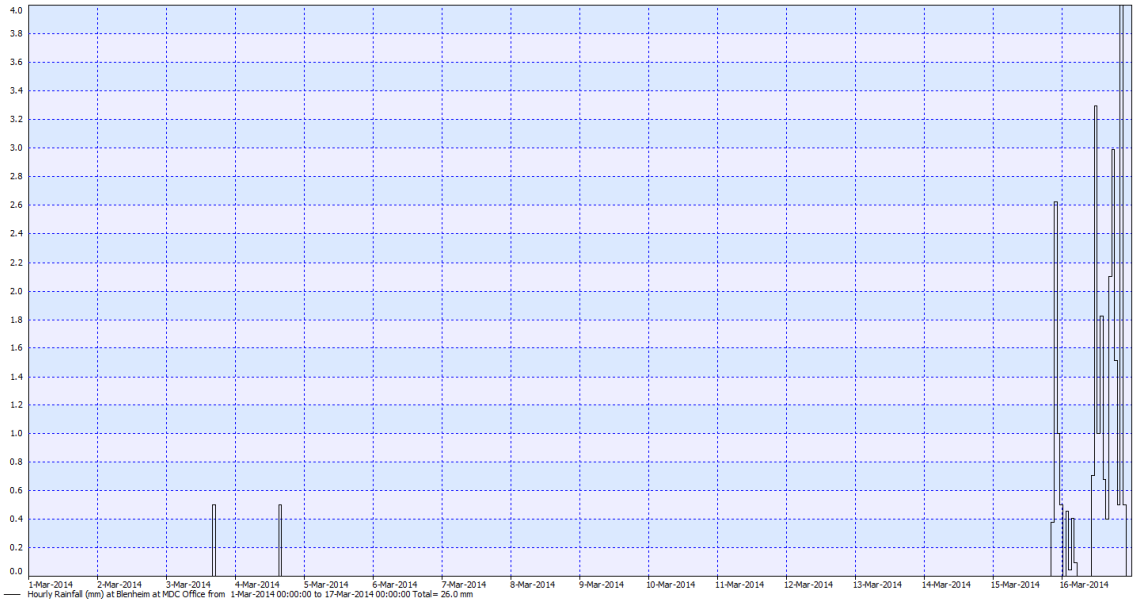

Figure 19: Hourly rainfall measured in Blenheim from the 1 March 2014 to the 17th March 2014.

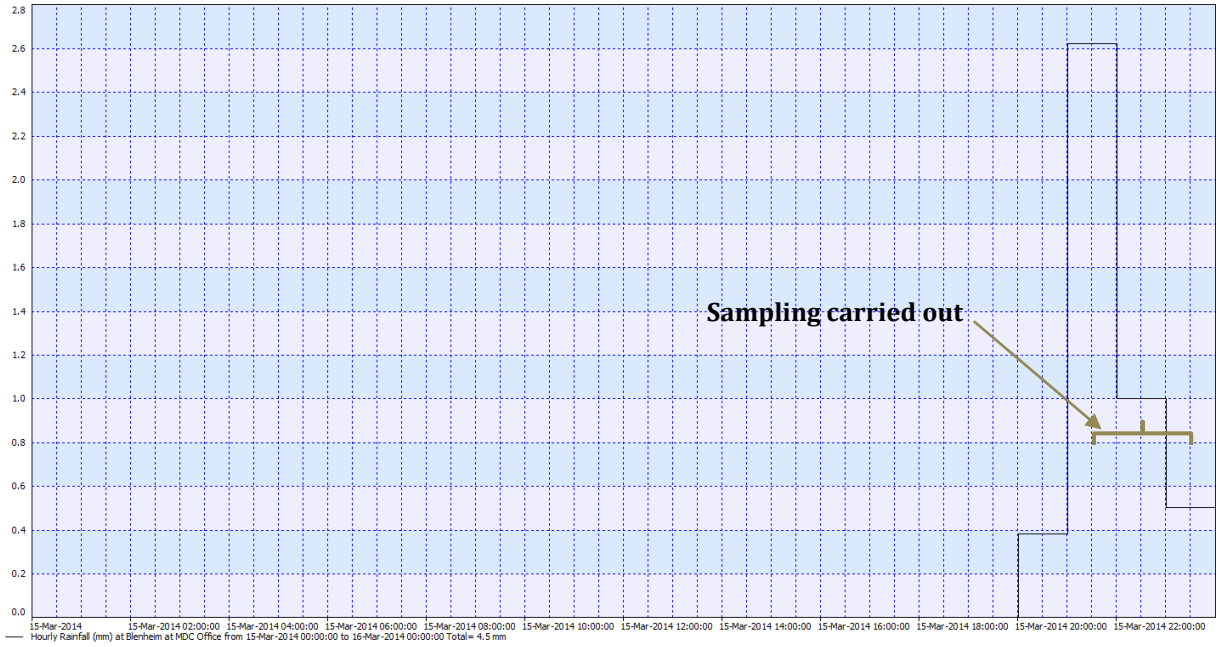

Figure 20: Hourly rainfall measured in Blenheim from the 15 March 2014 to the 17th March 2014. Time in NZST.

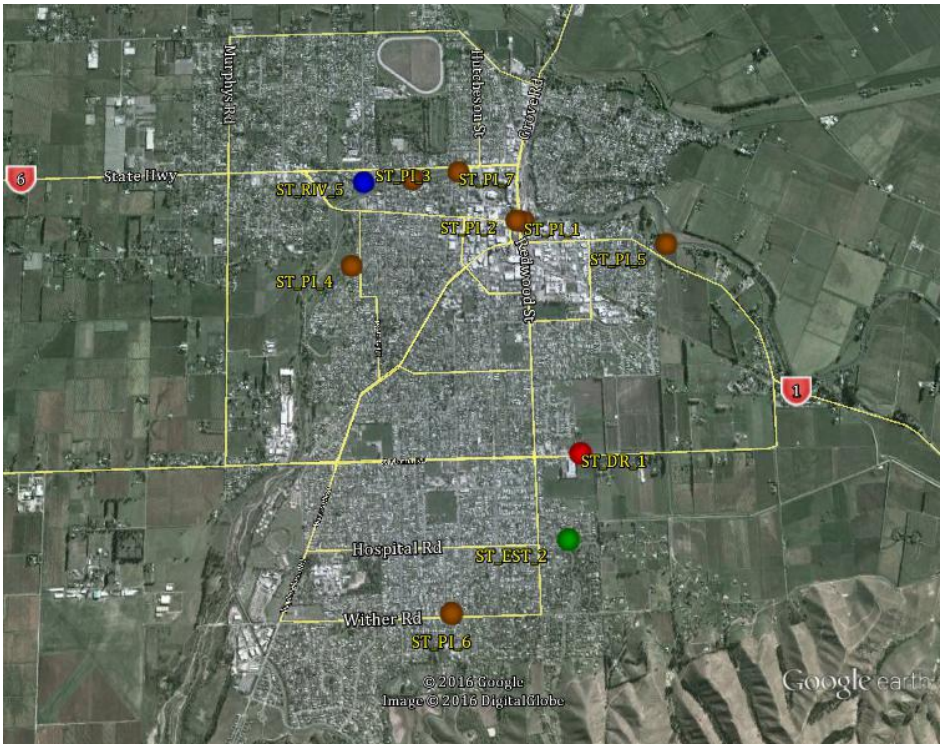

Figure 21: Locations of the sites sampled during the first flush event on the 15 March 2014.

3.2.1 General Water Quality

Results from the first flush event show that hardness and pH decrease during a first flush event. This may be a reflection of the lower pH of rainwater influencing pH at the sites. *E. coli* numbers and suspended solids concentrations both significantly increase during the event (Figure 22).

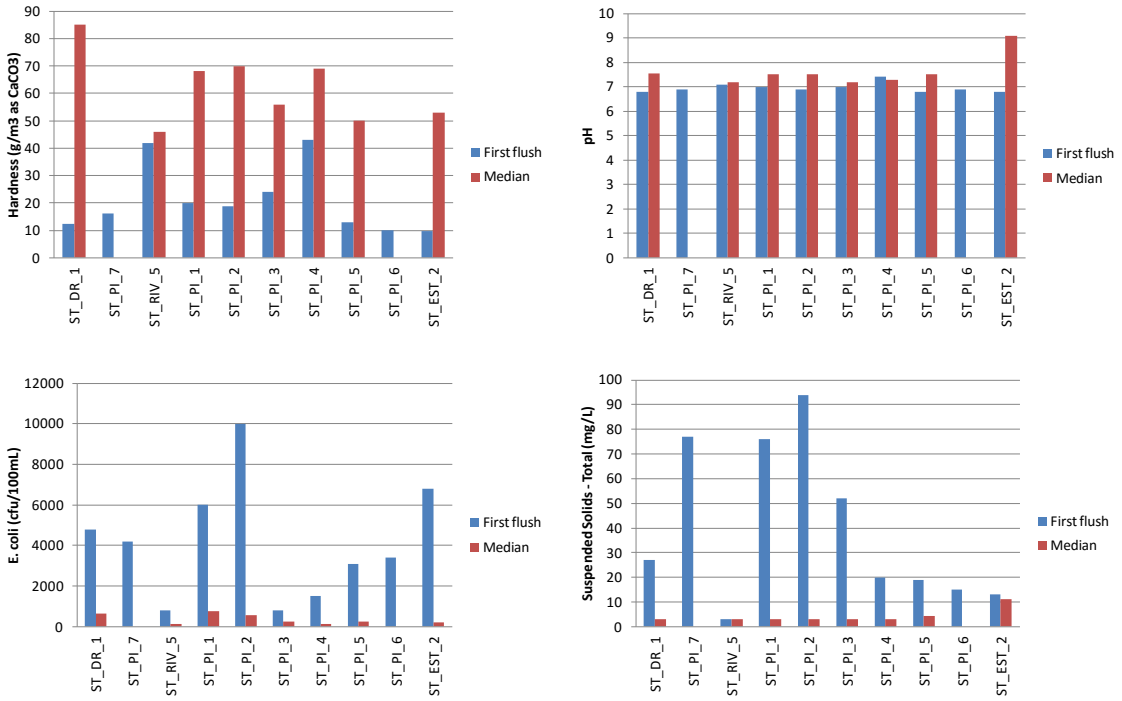

Figure 22: Comparison of results for general water quality between the first flush event and median results for the sites sampled.

3.2.2 Nutrients

Results from the first flush event show that dissolved reactive phosphorus concentrations increase significantly during a first flush event, in contrast nitrate concentrations were significantly decreased (Figure 23).

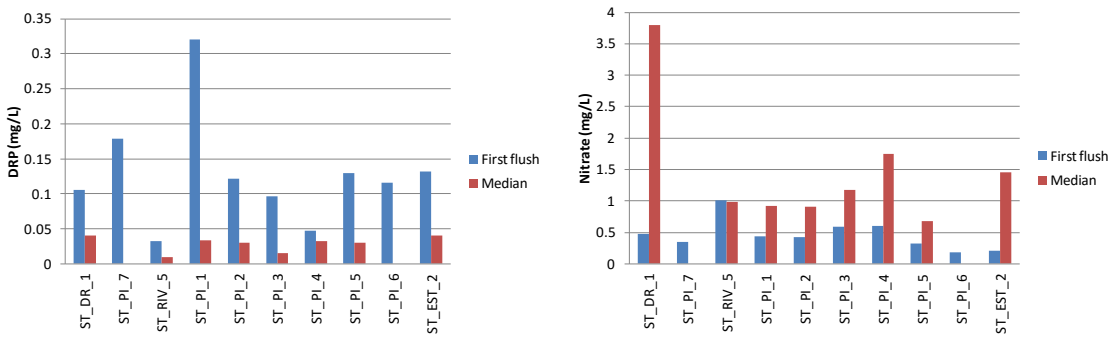

Figure 23: Comparison of results for nutrients between the first flush event and median results for the sites sampled.

3.2.3 Metals

Results from the first flush event show that all metal concentrations significantly increase during a first flush event (Figure 24). This is particularly evident at the pipe outfall sites.

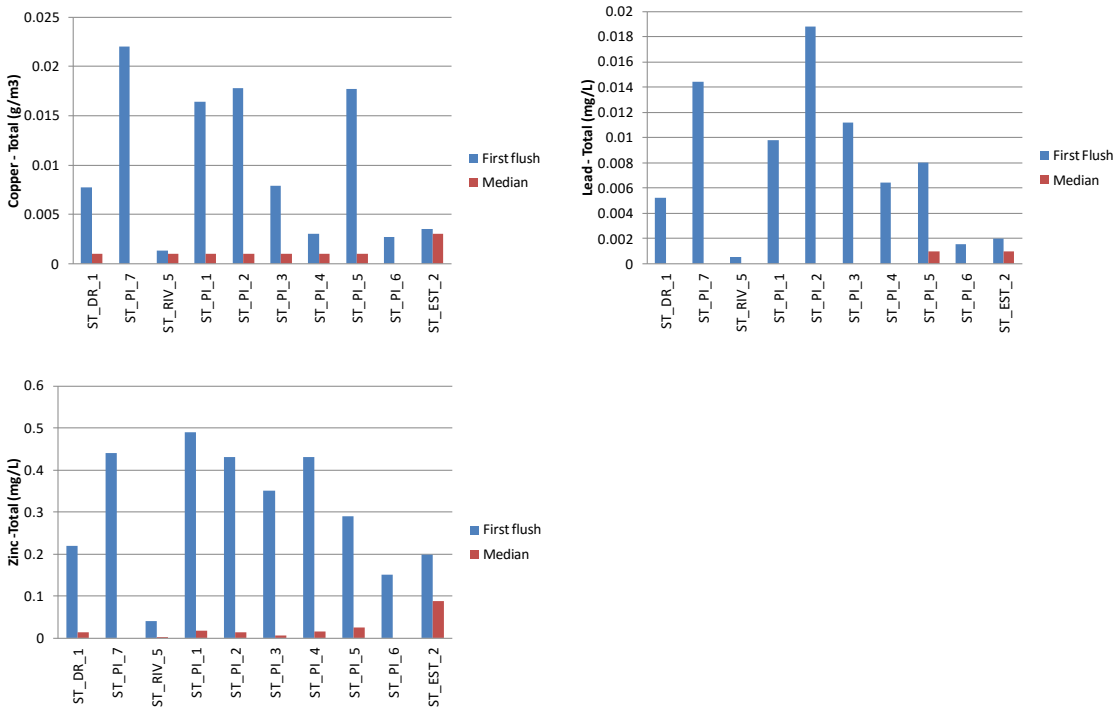

Figure 24: Comparison of results for metals between the first flush event and median results for the sites sampled.

4. DISCUSSION

Sites comprised of stormwater pipe outlets, drains, ephemeral streams, springs and rivers. Water quality in these types of sites is going to be highly variable with the worst quality expected in pipe outlets and drains and the best in springs and spring fed rivers and streams. This survey serves as a snap shot of the current stormwater quality in Blenheim and its impact on receiving water bodies. Naturally the biggest concern will be on impacts in high quality springs and spring fed rivers and streams, such as those located in north Blenheim. Nonetheless the water quality of drains and ephemeral streams need to be considered as these ultimately discharge to rivers and estuaries, the adverse cumulative impacts of which are most often observed in estuarine environments. In the case of Blenheim the Vernon Lagoons are the ultimate collection point for contaminants associated with stormwater discharges, particularly those discharges in the south of Blenheim (Figure 25).

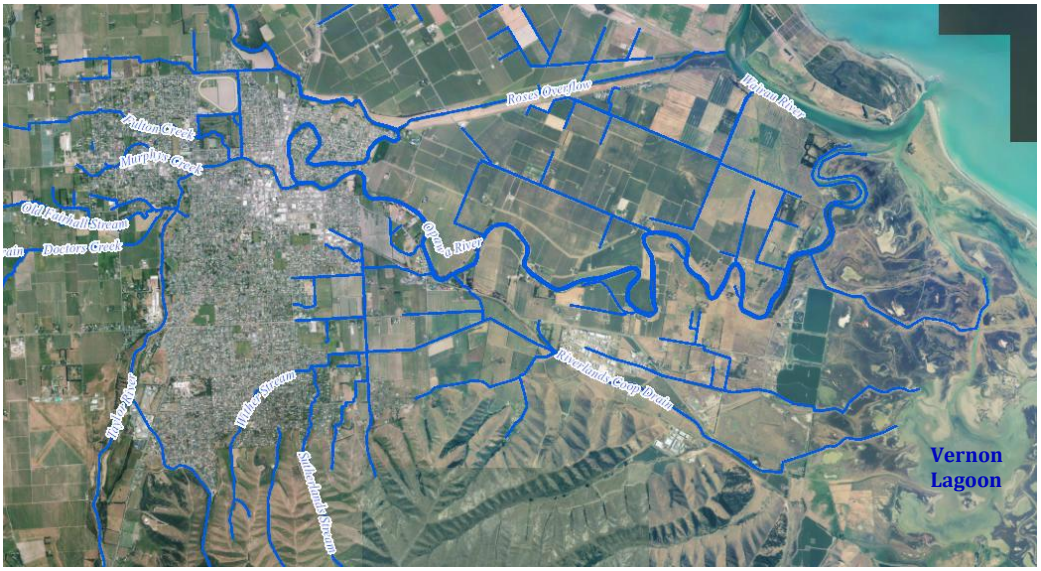

Figure 25: The main network of drains in Blenheim which ultimately discharge to the Vernon Lagoon.

Stormwater generated from urban surfaces during wet weather periods is the number one source of pollution in urban estuaries and coastal waters, and a leading source for both lakes and river systems (Novotny and Olem, 1994; Burton and Pitt, 2002). Urban stormwater contaminates include sediment, nutrients, heavy metals and microorganisms. Urban stormwater can also contribute hydrocarbons and pesticides/herbicides to surface waters, although these are more likely to be associated with specific events and areas e.g. hydrocarbon spill during a rainfall event or poor use of pesticides/herbicides in wet weather when much of the compound will readily wash off into stormwater drains and surface waters. Less common but still an important source of pollution is the direct discharge of contaminants (paints, pesticides, solvents etc.) into stormwater drains. MDC support educational programmes which place blue plastic fish (Figure 26) beside stormwater drains with a view to educating the general public about the adverse effects of such behaviour by reminding the public that what washes into the stormwater system ultimately has an effect on downstream ecology.

Figure 26: The 'blue fish' placed near drains to remind the public of the impacts of contaminants on aquatic life. From: www.fishondrains.com

The drain sites had the highest median *E. coli* numbers, however the pipe discharges (ST_PI_1 and ST_PI_4), which discharge to the Taylor River just upstream of the Opawa River confluence and to the Taylor River at Monro Street respectively, recorded the highest *E. coli* numbers (38,000 cfu/100mL). The high *E. coli* count for the discharge to the Taylor at Monro Street occurred in dry weather, with no appreciable rain for two weeks prior, this may indicate a cross connected sewer and should be investigated. In contrast the discharge to the Taylor River just upstream of the Opawa River was associated with the rainfall event on the 15 March 2014, albeit a somewhat delayed reaction, with *E. coli* numbers increasing as a result of the rainfall, then peaking more than a week later before reducing again (Figure 27).

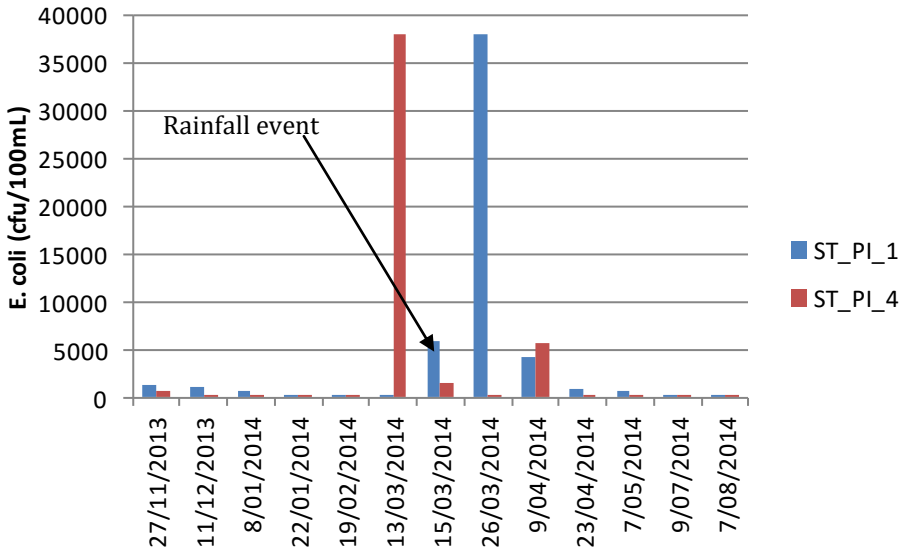

Figure 27: *E. coli* numbers for the pipe discharges to the Taylor River just upstream of the Opawa River (ST_PI_1) confluence and the Taylor at Monro Street (ST_PI_4)

McCarthy (2008) discusses a phenomenon called 'end flush' whereby it was noticed that for a significant number of events studied, the peak in *E. coli* concentrations occurred at the end of the events as opposed to at the start of an event. It was hypothesised that these 'end flushes' could be caused by the intrusion of a highly contaminated water source at the end of an event. This slow movement of wastewater into the stormwater system after a sufficiently large rainfall intensity effectively moves the water from the wastewater system into the stormwater system over a period of time (McCarthy, 2008). Whether or not this phenomenon accounts for the high numbers seen from the outlet pipe into the Taylor River upstream of the Opawa River is debatable but should be considered.

The drain site (ST_DR_5), the Town Branch Drain, had the highest median *E. coli* numbers with all but 3 samples being greater than 1,000 cfu/100mL. Faecal source tracking at this site, and potentially at the other drain sites where median *E. coli* numbers are very high, would help ascertain the source of the *E. coli*.

Copper is found at low concentrations in most waters. It is an essential trace element required by most aquatic organisms but can be toxic at higher concentrations. Copper toxicity decreases with increasing hardness and alkalinity. Zinc is also an essential trace metal but is toxic to aquatic organisms at higher concentrations. Lead is a non-essential metal and has no metabolic function.

Lead in the environment arises predominately from anthropogenic sources (ANZECC, 2000). Historically, the most significant source of lead in the urban environment was related to its use as an antiknock additive in petrol, which was phased out in New Zealand in 1996 and lead paint, commonly used up until the 1970s and in some cases the 1990s. Lead concentrations in New Zealand's surface waters have been declining since the phasing out of lead petrol and paints (Suren and Elliot, 2004).

The toxicity of metals is a function of the rate of metal uptake versus the rate of excretion. Increasing the bioavailability of trace metals causes an increase in the rate of uptake in relation to the rate of excretion and detoxification, and therefore the metals toxicity (Rainbow, 2002). Non-essential metals such as lead are generally toxic and need to be quickly detoxified or excreted (Rainbow 2002).

The pipe discharge (ST_PI_5) to the Lower Opawa has the highest metal concentrations of all of the pipe discharges, however due to the Opawa downstream sampling point being in a poor location, it is not known how much this is impacting on water quality in the lower Opawa. Nonetheless it would be useful to investigate the catchment serving this pipe discharge to ascertain where the source of these metals are and if there is some mitigation measure that could be taken to reduce the metal load to the river. The remaining pipe discharge sites had lower and very comparable metal concentrations.

The Town Branch Drain (ST_DR_5) has the poorest water quality by a significant margin compared with all other sites. The highest concentration of total nitrogen was recorded from the site from a sample taken on the 23 April 2014 (Figure 28). Field notes at the time of sampling state *'Lots of weed and rubbish backed up against the pump house screens*'. Nitrogen concentrations remained relatively high in relation to samples taken prior to that date. It is possible that organic debris accumulating at the pump house screens acts as a reservoir for nitrogen downstream. Regular cleaning of the screens may help mitigate the effects downstream in the Town Branch Drain and ultimately in the Vernon Lagoon. Similarly for phosphorus, where the highest concentrations of Total Phosphorus and Dissolved Reactive Phosphorus were measured (Figure 28). Rainfall data shows that the results from the sampling on the 23 April 2014 were not associated with a rainfall event, rather they are more likely a result of a build-up of organic debris from previous rainfall events (Figure 29).

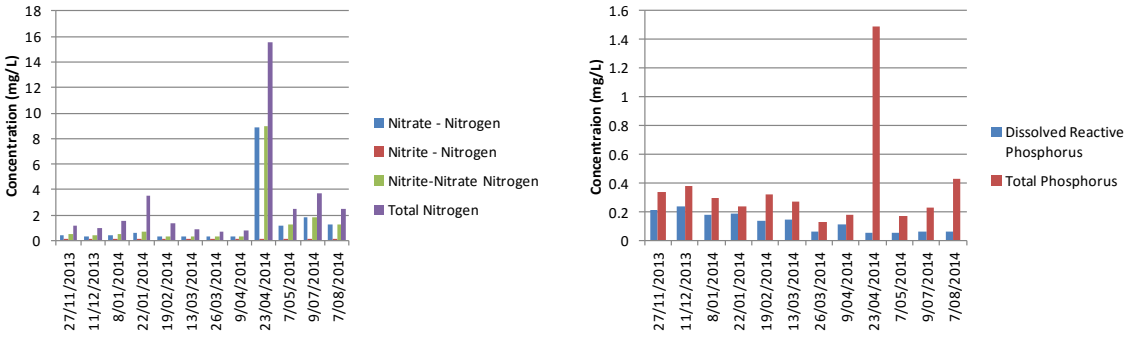

Figure 28: Nutrient concentrations recorded for the Town Branch Drain site (ST_DR_5)

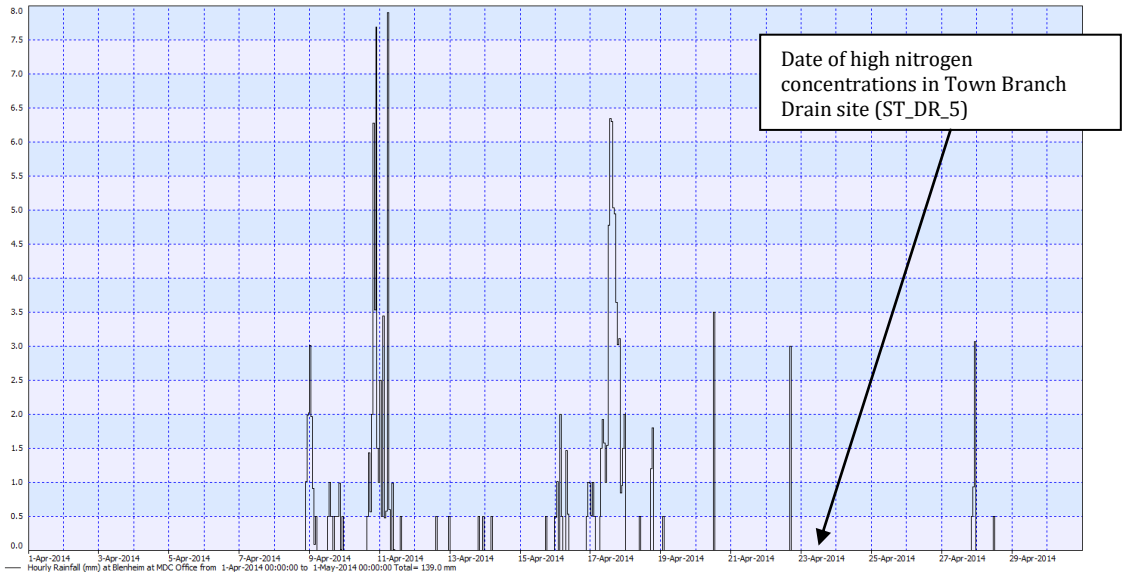

Figure 29: Rainfall in Blenheim from 1 April to 30 April 2014

As previously discussed *E. coli* numbers were consistently high (>1,000 cfu/100mL) during the monitoring period for the Town Branch Drain site (ST_DR_5). Metals were also highest at this site and show a similar time series pattern as that for nutrients (Figure 30).

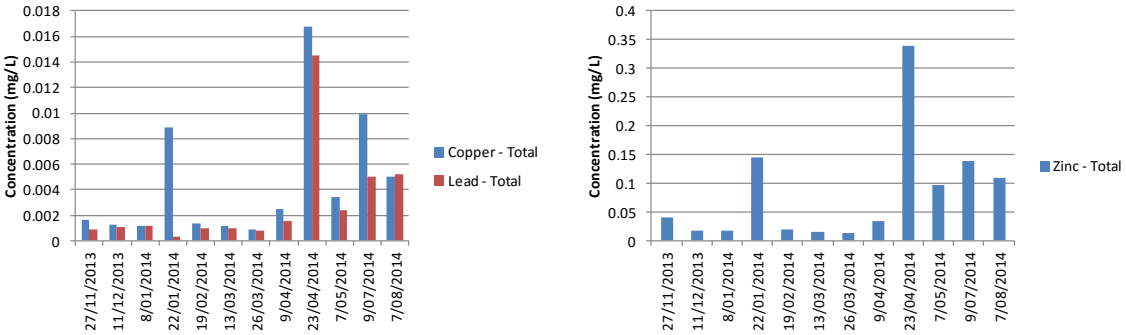

Figure 30: Metal concentrations for the Town Branch Drain site (ST_DR_5)

It is likely that the discharge from the Town Branch Pump Station (ST_PI_8) is having an adverse effect on water quality in the Town Branch Drain. However as there was only one sample taken from this discharge pipe other sources contributing to the poor water quality in the Town Branch Drain cannot be ruled out.

Organic compounds (hydrocarbons and pesticides) were all measured below their respective detection limits with the exception of pyrene, which was measured just above the detection limit from the stormwater pipe ST_PI_2 on the 9 July 2014. This stormwater pipe discharges to the Taylor River upstream of the Rail Bridge in the town centre. Organic compounds were not analysed for during the first flush event and it is possible that these compounds may be detected during such events.

5. SUMMARY AND RECOMMENDATIONS

A total of 3,754 results covering 15 different parameters over 31 different sites were collected over a ten month period in 2013-14. In addition, a full suite of pesticides and hydrocarbons were analysed for at five sites on two occasions.

A first flush sampling event, whereby ten sites were sampled during the initial stages of a rainfall event, was undertaken on the 15 March 2014.

Water quality for each of the sites was assessed to determine the general characteristics of the site in question. This assessment excluded sampling from the first flush event as it was determined that results from this event would likely skew results and that results from the event would be most informative if analysed separately. Results from the first flush event did show that contaminant concentrations peak during a first flush event when compared with median concentrations for the site.

A clear delineation between north Blenheim, where springs and springs fed rivers flow, and south Blenheim where slow flowing drains and ephemeral streams dominate was made with regard to water quality. Whilst higher values are placed on springs and springs fed rivers and streams the water quality of the drains and ephemeral streams should not be neglected as ultimately pollutants will discharge to the Vernon Lagoon.

Organic compounds (hydrocarbons and pesticides) were all below the limit of detection, with the exception of pyrene, which was recorded just above the limit of detection. However no analysis of organic compounds were undertaken during a first flush event. A sample during a first flush event at one of the pipe discharges, where the poorest water quality was recorded, would help ascertain whether these compounds from the stormwater network are potentially impacting on water quality downstream.

The discharge pipe ST_PI_5 had considerably poorer water quality than the other pipe discharges, however its effects on the Opawa River water quality (where it discharges to) are questionable due to the fact that the downstream monitoring point is not located far enough downstream to allow for reasonable mixing (Figure 31).

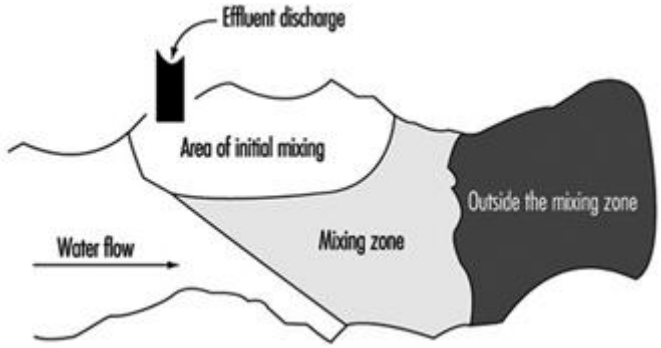

Figure 31: Diagrammatic depiction of mixing zones in a river downstream of a point discharge (from: www.iloencyclopaedia.org)

Future monitoring should relocate ST_RIV_9 further downstream of ST_PI_5 to allow for adequate mixing to ensure the downstream site is representative of water quality in the Opawa River after the stormwater discharge from ST_PI_5 has fully mixed.

The Town Branch Drain site (ST_RIV_5) had the poorest water quality of all the surface water sites.

Investigation, such as microbial source tracking for the pipe discharge at ST_PI_4 and for the Town Branch Drain (ST_DR_5) may help identify the source of faecal material and allow for mitigation measures to be taken to reduce the numbers entering the rivers and springs. Two stormwater pipes,

the discharging to the Taylor River (ST_PI_1 and ST_PI_2), also had consistently high *E. coli* numbers and are negatively impacting on water quality in the Taylor River.

Regular cleaning of stormwater screens, particularly at the Town Branch Drain pump site, may help decrease the overall load of contaminants downstream.

Copper and lead concentrations were mostly within the relevant guideline values for the river and stream sites, however zinc concentrations frequently exceeded the relevant ANZECC guidelines at sites located on Fultons Creek, the Taylor River and the Opawa River. Stormwater discharges are likely to be affecting water quality with regard to zinc concentrations in the Taylor and Opawa Rivers.

An assessment of the total impervious area as well as details of the activities (car parks, abattoirs, residential housing etc.) within each of the stormwater catchment zones would serve to help identify sources of contaminants and in turn allow for mitigation measures to be taken. This could be part of an overall stormwater policy and would serve to inform further monitoring and investigations.

6. REFERENCES

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Disclaimer

This report has been prepared solely for the benefit of you as our client and the relevant Local Authority with respect to the particular brief given to us, and data or opinions contained in it may not be used in other contexts or for any other purpose without our prior review and agreement.

This disclaimer shall apply notwithstanding that the report may be made available to any other person in connection with any application for permission or approval, or pursuant to any requirement of law.

Where data has been supplied by the client or other external sources it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by SEE Ltd for incomplete inaccurate data supplied by others.

This report is based on conditions found on site at the time of the site investigation/remediation and is consistent with standards currently being applied. The soil sampling undertaken provides an understanding of the conditions present but conditions may vary considerably over relatively small areas due to the nature of the site and the contamination.

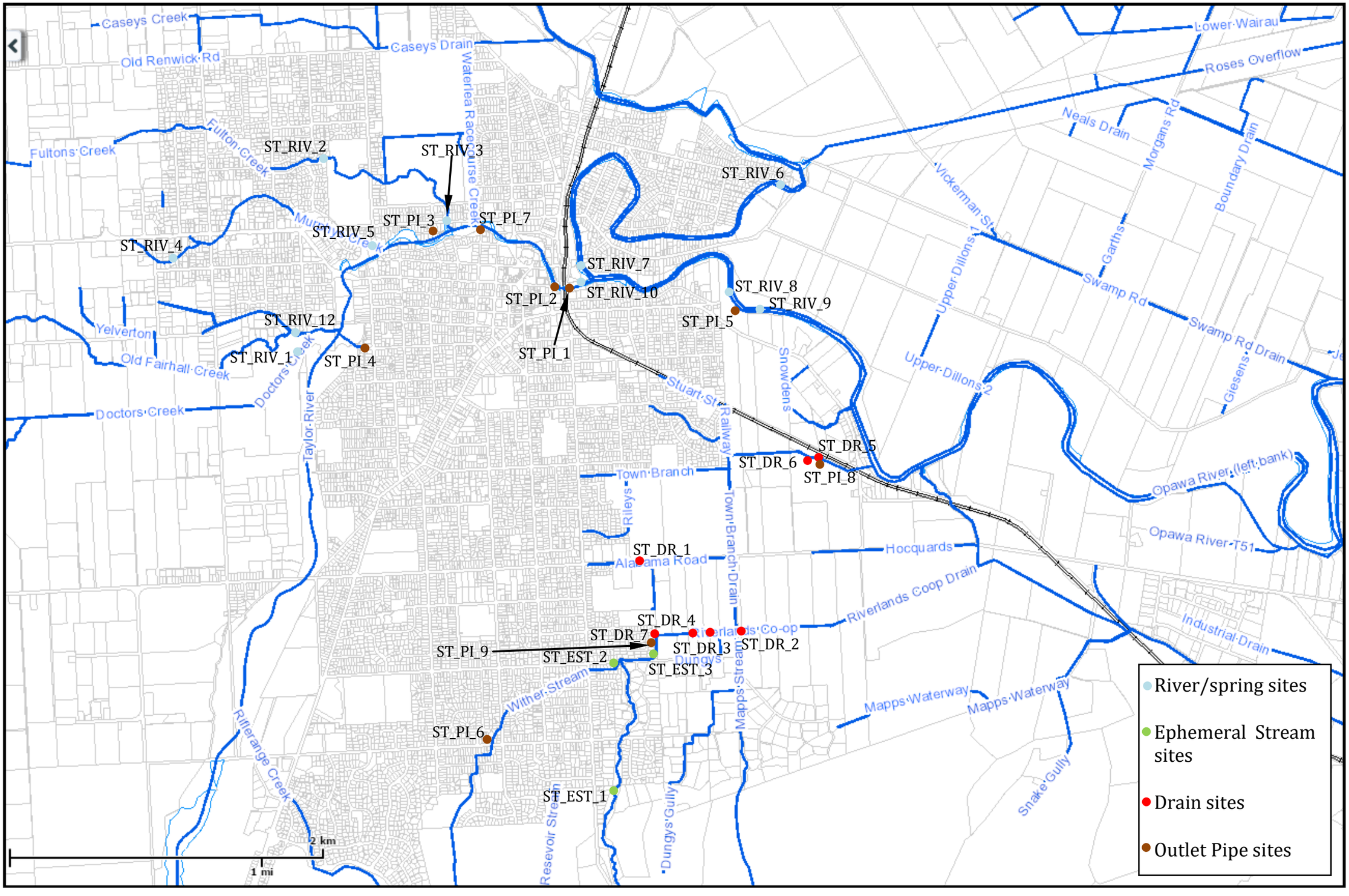
Fleur Tiernan

ENVIRONMENTAL SCIENTIST

SEE Ltd

APPENDIX 1

Site Location Plan and Site Photos


Caseys Creek
Old Renwick Rd
Caseys Drain
Waterlea Racecourse Creek
Fultons Creek
Fulton Creek
ST_RIV_2
ST_RIV_3
ST_RIV_6
Lower Wairau
Roses Overflow
Neals Drain
Morgans Rd
Boundary Drain
Vickerman St
Upper Dillons 1
Garths
Swamp Rd
Swamp Rd Drain
Giesens
Upper Dillons 2
ST_PI_3
ST_PI_7
ST_RIV_5
Murphys Creek
ST_RIV_4
ST_RIV_7
ST_RIV_8
ST_RIV_9
ST_PI_2
ST_RIV_10
ST_PI_5
Yelverton
ST_RIV_12
ST_RIV_1
ST_PI_4
Old Fairhall Creek
Doctors Creek
Taylor River
ST_PI_1
Snowdens
Stuart St Railway
ST_DR_5
ST_DR_6
ST_PI_8
Town Branch
Rileys
Town Branch Drain
Opawa River (left bank)
Opawa River T51
ST_DR_1
Alabama Road
Hocquards
Riverlands Coop Drain
ST_DR_4
ST_DR_7
Riverlands Co-op
ST_DR_2
ST_PI_9
ST_EST_2
ST_DR_3
Dungys
ST_EST_3
Industrial Drain
Wither Stream
Mapps Stream
Mapps Waterway
Mapps Waterway
ST_PI_6
Rifleange Creek
ST_EST_1
Reservoir Stream
Dungys Gully
Snake Gully
2 km
1 mi
River/spring sites
Ephemeral Stream sites
Drain sites
Outlet Pipe sites


ST_RIV_12 Yelverton Stream u/s Doctors Creek


ST_RIV_1 Doctors Creek u/s Taylor River


Stormwater outfall
Stormwater outfall
ST_RIV_2 Fultons at Mogridge Street


ST_RIV_3 Fultons at Nelson St


ST_RIV_5 Murphys Creek d/s

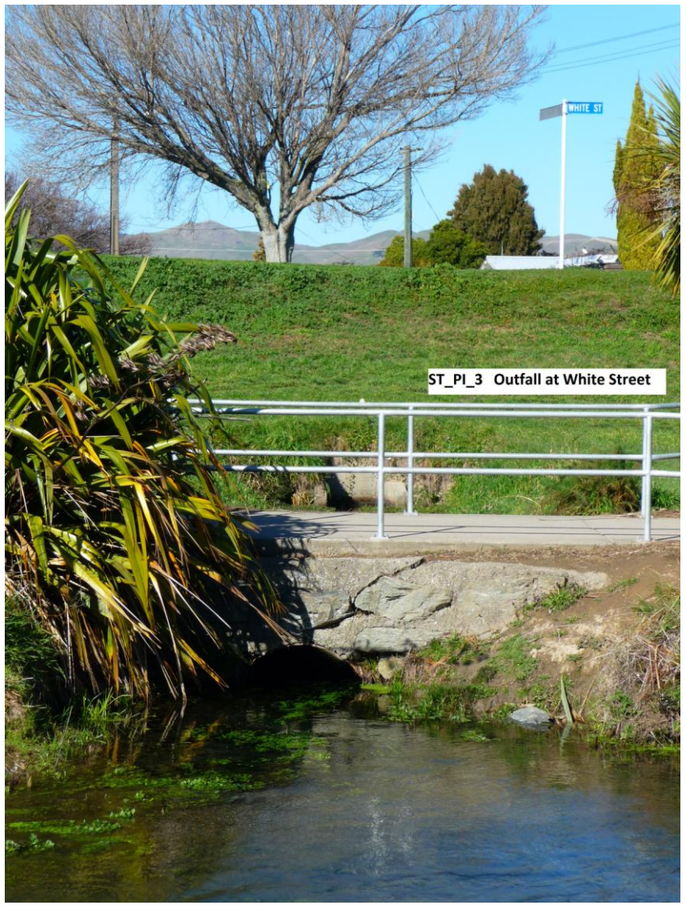

ST_RIV_7 Opawa Loop before Taylor River confluence


ST_RIV_11 Taylor River
u/s Hutcheson St Bridge


ST_PI_1
ST_PI_2
ST_RIV_10 Taylor River at River Queen

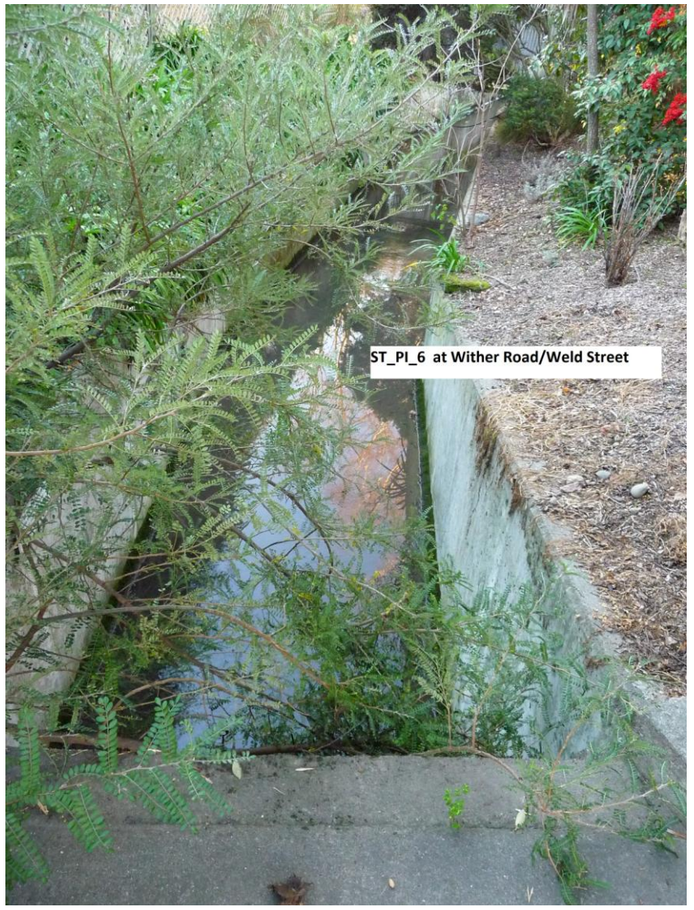

ST_PI_1 d/s Rail Bridge


ST_PI_2 Outfall (underwater) at Raupo steps


WHITE ST
ST_PI_3 Outfall at White Street


ST_PI_7 Outfall at Henry Street
Taylor River

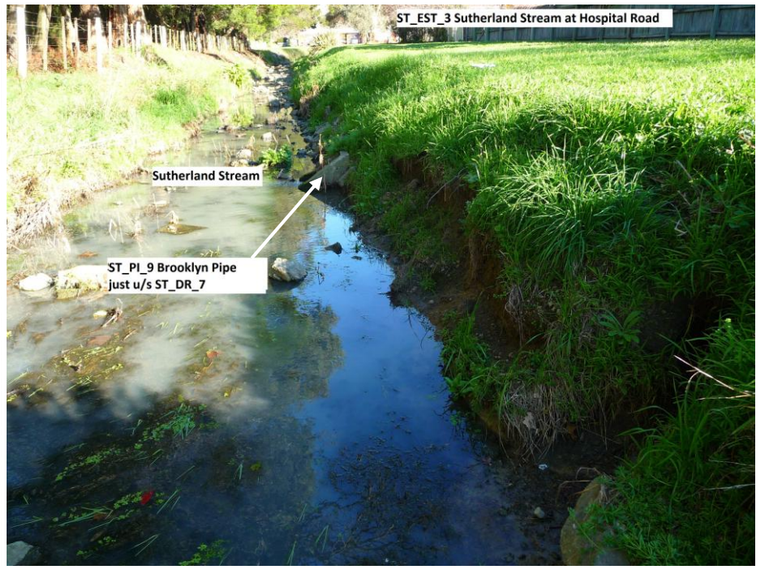

ST_PI_4 Outlet at Monro St


ST_PI_6 at Wither Road/Weld Street


ST_EST_2 Wither Stream u/s Sutherland Stream
Sutherland Stream


ST_EST_1 Sutherland Stream u/s at Farm Park


ST_EST_3 Sutherland Stream at Hospital Road


ST_EST_3 Sutherland Stream at Hospital Road
Sutherland Stream
ST_PI_9 Brooklyn Pipe just u/s ST_DR_7

NOTE: Photos of all sites was not possible due to access difficulties

APPENDIX 2

Summary Statistics for General Water Quality

Summary statistics for Dissolved Calcium (g/m³) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	22.667	23	19	25	25	20.5	2.229	12
ST_DR_2	13.158	12.85	9.9	21	13.5	11.75	2.848	12
ST_DR_3	9.4	9.4	9.4	9.4	-	-	0	1
ST_DR_4	13.2	13.2	13.2	13.2	-	-	0	1
ST_DR_5	26.067	26.5	7.8	50	29	21.3	9.971	12
ST_DR_6	14.2	14.2	14.2	14.2	-	-	0	1
ST_DR_7	7.4	7.4	7.4	7.4	-	-	0	1
ST_EST_1	20	20	20	20	-	-	0	1
ST_EST_2	13.222	13	5.4	19.8	15.85	11.45	4.201	9
ST_PI_1	17.825	18	14.6	19.5	18.9	17.25	1.429	12
ST_PI_2	18.155	18.2	16.1	19.7	18.925	17.85	1.117	11
ST_PI_3	15.218	15.2	14.4	15.9	15.525	15.025	0.433	11
ST_PI_4	18.017	18.15	16	19.5	18.6	17.7	1.011	12
ST_PI_5	14.55	13.7	11.9	19.7	16.1	12.9	2.546	10
ST_PI_8	18.2	18.2	18.2	18.2	-	-	0	1
ST_RIV_1	16.525	16.45	15	17.7	17.1	16.15	0.772	12
ST_RIV_10	14.517	14.8	13.4	15.2	15	14.05	0.589	12
ST_RIV_11	13.55	13.55	12.2	14.2	14.1	13.25	0.654	12
ST_RIV_12	15.158	15.1	13.7	16.1	15.5	14.9	0.635	12
ST_RIV_2	13.483	13.65	7.5	17.2	15.1	12.1	2.588	12
ST_RIV_3	16.317	13.65	11.6	49	14.75	12.1	10.371	12
ST_RIV_4	12.109	12.4	9.1	13.5	12.875	11.6	1.253	11
ST_RIV_5	12.717	12.9	12	13.3	13.05	12.15	0.482	12
ST_RIV_6	9.075	8.5	7.7	15	8.95	8.2	1.939	12
ST_RIV_7	9.136	8.8	7.7	11.9	9.575	8.55	1.148	11
ST_RIV_8	12.536	12.6	10.7	13.8	13.075	11.975	0.856	11
ST_RIV_9	14.225	14.3	12.9	15.4	14.9	13.55	1.028	4

Summary statistics for Hardness (g/m^3 as $CaCO_3$) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	84.25	85	70	94	92.5	76	8.433	12
ST_DR_2	56.5	56	41	81	58	53.5	9.803	12
ST_DR_3	45	45	45	45	-	-	0	1
ST_DR_4	58	58	58	58	-	-	0	1
ST_DR_5	103.167	103	29	200	117.5	83	41.136	12
ST_DR_6	55	55	55	55	-	-	0	1
ST_DR_7	31	31	31	31	-	-	0	1
ST_EST_1	100	100	100	100	-	-	0	1
ST_EST_2	52.489	53	18.4	75	62.25	47.25	16.081	9
ST_PI_1	67.25	68	54	75	71	65.5	5.895	12
ST_PI_2	70	70	60	75	73	70	4.604	11
ST_PI_3	55.545	56	53	59	56	55	1.508	11
ST_PI_4	68	69	58	74	70	67	4.612	12
ST_PI_5	54.6	50	43	78	61	46	12.02	10
ST_PI_8	67	67	67	67	-	-	0	1
ST_RIV_1	61.417	61	56	66	64	59.5	3.288	12
ST_RIV_10	53.25	53.5	49	57	55	51	2.34	12
ST_RIV_11	48.917	49	45	52	51	47.5	2.314	12
ST_RIV_12	54.417	54.5	49	59	55.5	53.5	2.353	12
ST_RIV_2	49.083	48.5	26	70	56	43	10.908	12
ST_RIV_3	56.167	50	41	148	52.5	43	29.341	12
ST_RIV_4	42.455	44	32	47	45	41	4.298	11
ST_RIV_5	45.167	46	43	47	46.5	43	1.697	12
ST_RIV_6	32.333	30.5	27	55	32	29	7.402	12
ST_RIV_7	32.909	32	27	43	34.25	31	4.206	11
ST_RIV_8	45.545	46	38	52	47.75	43.5	3.671	11
ST_RIV_9	52.5	53	46	58	56	49	5	4

Summary statistics for Dissolved Magnesium (g/m³) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	6.608	6.8	5.5	7.5	7.25	5.95	0.714	12
ST_DR_2	5.775	5.9	3.9	7.1	6.1	5.5	0.789	12
ST_DR_3	5.3	5.3	5.3	5.3	-	-	0	1
ST_DR_4	6.1	6.1	6.1	6.1	-	-	0	1
ST_DR_5	9.375	8.75	2.4	19.4	11.25	7.3	4.235	12
ST_DR_6	4.8	4.8	4.8	4.8	-	-	0	1
ST_DR_7	3.1	3.1	3.1	3.1	-	-	0	1
ST_EST_1	11.8	11.8	11.8	11.8	-	-	0	1
ST_EST_2	4.737	5.1	1.23	6.2	5.95	4.05	1.585	9
ST_PI_1	5.542	5.6	4.3	6.7	5.85	5.45	0.633	12
ST_PI_2	6	6.1	4.8	6.4	6.3	6.025	0.48	11
ST_PI_3	4.236	4.2	4.1	4.7	4.275	4.125	0.169	11
ST_PI_4	5.6	5.65	4.4	6.4	5.85	5.5	0.531	12
ST_PI_5	4.47	3.8	3.2	7.1	5	3.5	1.399	10
ST_PI_8	5.3	5.3	5.3	5.3	-	-	0	1
ST_RIV_1	4.908	4.8	4.3	5.5	5.25	4.6	0.414	12
ST_RIV_10	4.15	4.2	3.7	4.6	4.35	3.95	0.265	12
ST_RIV_11	3.675	3.7	3.3	4.1	3.85	3.5	0.226	12
ST_RIV_12	4.042	4.05	3.6	4.5	4.15	3.9	0.231	12
ST_RIV_2	3.719	3.4	1.83	6.7	4.15	3.15	1.171	12
ST_RIV_3	3.725	3.5	3	6	3.95	3.2	0.823	12
ST_RIV_4	2.991	3.1	2.4	3.3	3.175	2.825	0.288	11
ST_RIV_5	3.233	3.25	3	3.5	3.3	3.1	0.144	12
ST_RIV_6	2.364	2.25	1.88	4.2	2.4	2	0.611	12
ST_RIV_7	2.433	2.3	1.96	3.3	2.575	2.225	0.369	11
ST_RIV_8	3.482	3.6	2.8	4.3	3.7	3.2	0.402	11
ST_RIV_9	4.175	4.3	3.4	4.7	4.55	3.8	0.556	4

Summary statistics for pH (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	7.567	7.55	7.3	7.9	7.65	7.45	0.172	12
ST_DR_2	7.6	7.55	7.4	8	7.75	7.45	0.191	12
ST_DR_3	7.4	7.4	7.4	7.4	-	-	0	1
ST_DR_4	7.9	7.9	7.9	7.9	-	-	0	1
ST_DR_5	7.767	7.8	7.4	8	7.9	7.7	0.197	12
ST_DR_6	7.7	7.7	7.7	7.7	-	-	0	1
ST_DR_7	7.4	7.4	7.4	7.4	-	-	0	1
ST_EST_1	7.8	7.8	7.8	7.8	-	-	0	1
ST_EST_2	8.867	9.1	7.6	9.5	9.325	8.675	0.709	9
ST_PI_1	7.533	7.5	7.4	7.7	7.6	7.5	0.098	12
ST_PI_2	7.482	7.5	7.4	7.8	7.5	7.4	0.117	11
ST_PI_3	7.191	7.2	6.9	7.6	7.275	7.1	0.181	11
ST_PI_4	7.367	7.3	7.2	7.7	7.4	7.3	0.15	12
ST_PI_5	7.53	7.5	7.2	7.9	7.6	7.5	0.177	10
ST_PI_8	7.6	7.6	7.6	7.6	-	-	0	1
ST_RIV_1	7.533	7.5	7.4	7.8	7.6	7.45	0.115	12
ST_RIV_10	7.517	7.5	7.4	7.8	7.6	7.4	0.127	12
ST_RIV_11	7.458	7.4	7.3	7.8	7.5	7.4	0.138	12
ST_RIV_12	7.408	7.35	7.2	7.8	7.55	7.25	0.193	12
ST_RIV_2	7.408	7.4	7.1	7.6	7.5	7.3	0.144	12
ST_RIV_3	7.425	7.35	7.2	7.7	7.55	7.3	0.171	12
ST_RIV_4	7.118	7.1	6.9	7.6	7.175	7	0.183	11
ST_RIV_5	7.2	7.2	7.1	7.4	7.25	7.1	0.095	12
ST_RIV_6	7.458	7.5	7.2	7.6	7.5	7.4	0.1	12
ST_RIV_7	7.491	7.5	7.3	7.6	7.6	7.4	0.104	11
ST_RIV_8	7.509	7.5	7.3	7.8	7.6	7.4	0.138	11
ST_RIV_9	7.5	7.4	7.4	7.8	7.6	7.4	0.2	4

Summary statistics for Total Suspended Solids (g/m^3) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	3.583	3	3	7	3.5	3	1.24	12
ST_DR_2	30.167	23	10	85	38.5	13.5	22.036	12
ST_DR_3	21	21	21	21	-	-	0	1
ST_DR_4	10	10	10	10	-	-	0	1
ST_DR_5	115.833	23.5	4	540	109.5	15.5	193.183	12
ST_DR_6	21	21	21	21	-	-	0	1
ST_DR_7	33	33	33	33	-	-	0	1
ST_EST_1	5	5	5	5	-	-	0	1
ST_EST_2	11.667	11	4	28	15	4.75	8.155	9
ST_PI_1	14.083	3	3	87	8	3	25.532	12
ST_PI_2	3.455	3	3	8	3	3	1.508	11
ST_PI_3	5.727	3	3	18	8	3	4.819	11
ST_PI_4	3.333	3	3	5	3	3	0.778	12
ST_PI_5	10.8	4.5	3	69	5	3	20.509	10
ST_PI_8	18	18	18	18	-	-	0	1
ST_RIV_1	4.833	4.5	3	8	6.5	3	1.801	12
ST_RIV_10	3.417	3	3	5	3.5	3	0.793	12
ST_RIV_11	3.583	3	3	7	3.5	3	1.24	12
ST_RIV_12	3.25	3	3	5	3	3	0.622	12
ST_RIV_2	3.333	3	3	5	3	3	0.778	12
ST_RIV_3	4.083	3	3	12	3	3	2.746	12
ST_RIV_4	9.909	3	3	36	12	3	12.919	11
ST_RIV_5	3.167	3	3	5	3	3	0.577	12
ST_RIV_6	3.583	3	3	6	3.5	3	1.165	12
ST_RIV_7	4	3	3	11	3.75	3	2.408	11
ST_RIV_8	3.455	3	3	5	4	3	0.688	11
ST_RIV_9	51.25	59.5	10	76	74.5	28	30.631	4

Summary statistics for *E. coli* (cfu/100mL) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard Deviation (denom. = n-1)	Sample size
ST_DR_1	1426	650	200	5000	2350	355	1506.293	12
ST_DR_2	1930	1350	260	4400	3300	850	1428.884	12
ST_DR_3	31	30.5	1	60	60	1	41.719	2
ST_DR_4	276	276	1	550	550	1	388.202	2
ST_DR_5	2456	2200	100	5600	3650	1250	1723.092	12
ST_DR_6	120	120	120	120	-	-	0	1
ST_DR_7	1400	1400	1400	1400	-	-	0	1
ST_EST_1	86	86	86	86	-	-	0	1
ST_EST_2	403	215	17	1400	410	50	496.445	10
ST_EST_3	20	20	20	20	-	-	0	1
ST_PI_1	4027	750	100	38000	1300	160	10760.559	12
ST_PI_2	1334	550	80	4000	2300	235	1482.931	11
ST_PI_3	587	270	38	2100	1085	112.5	706.018	11
ST_PI_4	3788	120	10	38000	510	63.5	10896.652	12
ST_PI_5	461	255	40	1600	800	110	512.932	10
ST_PI_8	6000	6000	6000	6000	-	-	0	1
ST_PI_9	49	49	49	49	-	-	0	1
ST_RIV_1	508	295	160	2100	480	215	564.642	12
ST_RIV_10	347	275	40	1500	330	130	392.506	12
ST_RIV_11	242	235	60	500	300	160	125.324	12
ST_RIV_12	510	245	140	1700	740	175	536.86	12
ST_RIV_2	481	135	56	4100	215	95	1142.834	12
ST_RIV_3	444	145	62	2800	405	95	777.334	12
ST_RIV_4	283	6	1	2700	80	2.5	805.338	11
ST_RIV_5	121	145	13	260	160	55	76.426	12
ST_RIV_6	126	100	36	230	190	80	67.55	12
ST_RIV_7	144	110	32	390	167.5	92.5	92.954	11
ST_RIV_8	299	140	70	1700	217.5	110	469.861	11
ST_RIV_9	308	285	160	500	425	190	150.859	4

APPENDIX 3

Summary Statistics for Nutrients

Summary statistics for Nitrate Nitrogen (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	3.637	3.8	0.48	5.1	3.925	3.475	1.104	13
ST_DR_2	2.531	2.45	1.97	3.5	2.7	2.2	0.437	12
ST_DR_3	1.09	1.09	1.09	1.09	-	-	0	1
ST_DR_4	2.5	2.5	2.5	2.5	-	-	0	1
ST_DR_5	1.356	0.43	0.3	8.9	1.24	0.325	2.428	12
ST_DR_6	1.21	1.21	1.21	1.21	-	-	0	1
ST_DR_7	1.07	1.07	1.07	1.07	-	-	0	1
ST_EST_1	0.61	0.61	0.61	0.61	-	-	0	1
ST_EST_2	1.236	1.39	0.002	2.9	1.6	0.51	0.846	10
ST_PI_1	0.905	0.91	0.44	1.13	1.002	0.857	0.168	13
ST_PI_2	0.875	0.905	0.43	1.1	0.97	0.8	0.176	12
ST_PI_3	1.133	1.165	0.59	1.31	1.21	1.11	0.184	12
ST_PI_4	1.687	1.74	0.6	2.3	1.952	1.535	0.407	13
ST_PI_5	0.726	0.65	0.32	1.66	0.772	0.497	0.368	11
ST_PI_6	0.182	0.182	0.182	0.182	-	-	0	1
ST_PI_7	0.35	0.35	0.35	0.35	-	-	0	1
ST_PI_8	0.002	0.002	0.002	0.002	-	-	0	1
ST_RIV_1	0.746	0.705	0.55	1.02	0.84	0.66	0.149	12
ST_RIV_10	0.834	0.85	0.64	1	0.91	0.745	0.112	12
ST_RIV_11	0.834	0.865	0.6	1.07	0.9	0.74	0.127	12
ST_RIV_12	0.815	0.785	0.65	1.08	0.885	0.715	0.128	12
ST_RIV_2	0.883	0.91	0.31	1.3	1.065	0.81	0.305	12
ST_RIV_3	1.023	0.955	0.71	1.6	1.165	0.8	0.279	12
ST_RIV_4	0.706	0.69	0.07	1.18	0.837	0.53	0.317	11
ST_RIV_5	1.012	0.99	0.83	1.38	1.042	0.885	0.168	13
ST_RIV_6	0.244	0.181	0.11	0.8	0.255	0.152	0.187	12
ST_RIV_7	0.265	0.156	0.065	0.67	0.463	0.123	0.206	11
ST_RIV_8	0.885	0.61	0.45	3.6	0.76	0.525	0.909	11
ST_RIV_9	0.542	0.545	0.38	0.7	0.685	0.4	0.166	4

Summary statistics for Nitrite Nitrogen (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0.005	0.003	0.002	0.02	0.004	0.002	0.005	13
ST_DR_2	0.029	0.031	0.005	0.054	0.044	0.009	0.018	12
ST_DR_3	0.005	0.005	0.005	0.005	-	-	0	1
ST_DR_4	0.004	0.004	0.004	0.004	-	-	0	1
ST_DR_5	0.049	0.051	0.011	0.109	0.061	0.029	0.027	12
ST_DR_6	0.036	0.036	0.036	0.036	-	-	0	1
ST_DR_7	0.009	0.009	0.009	0.009	-	-	0	1
ST_EST_1	0.002	0.002	0.002	0.002	-	-	0	1
ST_EST_2	0.018	0.01	0.005	0.068	0.019	0.009	0.019	10
ST_PI_1	0.005	0.002	0.002	0.02	0.003	0.002	0.006	13
ST_PI_2	0.005	0.002	0.002	0.02	0.005	0.002	0.006	12
ST_PI_3	0.004	0.002	0.002	0.02	0.002	0.002	0.005	12
ST_PI_4	0.005	0.003	0.002	0.02	0.004	0.002	0.005	13
ST_PI_5	0.007	0.006	0.002	0.02	0.008	0.003	0.005	11
ST_PI_6	0.009	0.009	0.009	0.009	-	-	0	1
ST_PI_7	0.011	0.011	0.011	0.011	-	-	0	1
ST_PI_8	0.002	0.002	0.002	0.002	-	-	0	1
ST_RIV_1	0.006	0.005	0.002	0.02	0.005	0.003	0.005	12
ST_RIV_10	0.004	0.003	0.002	0.02	0.003	0.003	0.005	12
ST_RIV_11	0.004	0.002	0.002	0.02	0.002	0.002	0.005	12
ST_RIV_12	0.005	0.003	0.002	0.02	0.005	0.003	0.005	12
ST_RIV_2	0.007	0.004	0.002	0.021	0.011	0.002	0.007	12
ST_RIV_3	0.006	0.002	0.002	0.023	0.005	0.002	0.007	12
ST_RIV_4	0.006	0.002	0.002	0.02	0.007	0.002	0.007	11
ST_RIV_5	0.003	0.002	0.002	0.02	0.002	0.002	0.005	13
ST_RIV_6	0.004	0.002	0.002	0.02	0.003	0.002	0.005	12
ST_RIV_7	0.004	0.003	0.002	0.02	0.003	0.002	0.005	11
ST_RIV_8	0.006	0.004	0.002	0.02	0.005	0.003	0.005	11
ST_RIV_9	0.013	0.013	0.007	0.02	0.018	0.009	0.007	3

Summary statistics for Nitrite Nitrate Nitrogen (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	3.638	3.8	0.49	5.1	3.925	3.475	1.102	13
ST_DR_2	2.573	2.5	1.98	3.6	2.75	2.25	0.442	12
ST_DR_3	1.1	1.1	1.1	1.1	-	-	0	1
ST_DR_4	2.5	2.5	2.5	2.5	-	-	0	1
ST_DR_5	1.406	0.495	0.32	9	1.275	0.365	2.442	12
ST_DR_6	1.25	1.25	1.25	1.25	-	-	0	1
ST_DR_7	1.08	1.08	1.08	1.08	-	-	0	1
ST_EST_1	0.62	0.62	0.62	0.62	-	-	0	1
ST_EST_2	1.252	1.425	0.007	2.9	1.62	0.52	0.845	10
ST_PI_1	0.911	0.92	0.45	1.14	1.002	0.86	0.167	13
ST_PI_2	0.878	0.91	0.44	1.1	0.97	0.8	0.174	12
ST_PI_3	1.134	1.165	0.59	1.31	1.21	1.11	0.185	12
ST_PI_4	1.689	1.75	0.61	2.3	1.96	1.535	0.405	13
ST_PI_5	0.734	0.66	0.33	1.67	0.772	0.5	0.369	11
ST_PI_6	0.192	0.192	0.192	0.192	-	-	0	1
ST_PI_7	0.36	0.36	0.36	0.36	-	-	0	1
ST_PI_8	0.004	0.004	0.004	0.004	-	-	0	1
ST_RIV_1	0.748	0.705	0.56	1.02	0.84	0.66	0.146	12
ST_RIV_10	0.836	0.855	0.64	1	0.915	0.745	0.113	12
ST_RIV_11	0.836	0.865	0.61	1.07	0.9	0.74	0.124	12
ST_RIV_12	0.819	0.795	0.66	1.08	0.885	0.72	0.125	12
ST_RIV_2	0.889	0.915	0.31	1.3	1.075	0.82	0.305	12
ST_RIV_3	1.027	0.96	0.71	1.6	1.18	0.8	0.28	12
ST_RIV_4	0.71	0.69	0.078	1.18	0.837	0.535	0.314	11
ST_RIV_5	1.012	0.99	0.83	1.38	1.042	0.885	0.168	13
ST_RIV_6	0.245	0.181	0.111	0.8	0.255	0.154	0.186	12
ST_RIV_7	0.268	0.159	0.068	0.68	0.463	0.126	0.208	11
ST_RIV_8	0.889	0.62	0.46	3.6	0.77	0.528	0.908	11
ST_RIV_9	0.55	0.555	0.39	0.7	0.69	0.41	0.163	4

Summary statistics for Total Nitrogen (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	3.878	4	1.31	5.3	4.1	3.775	0.941	13
ST_DR_2	3.325	3.3	2.8	4.6	3.45	3	0.473	12
ST_DR_3	1.87	1.87	1.87	1.87	-	-	0	1
ST_DR_4	3.1	3.1	3.1	3.1	-	-	0	1
ST_DR_5	2.933	1.44	0.74	15.5	3	0.955	4.09	12
ST_DR_6	2.3	2.3	2.3	2.3	-	-	0	1
ST_DR_7	1.95	1.95	1.95	1.95	-	-	0	1
ST_EST_1	1.14	1.14	1.14	1.14	-	-	0	1
ST_EST_2	2.067	2.025	0.77	4	2.5	1.48	0.896	10
ST_PI_1	1.572	1.13	0.92	6.1	1.258	1.09	1.391	13
ST_PI_2	1.259	1.115	0.91	2.9	1.23	1.05	0.532	12
ST_PI_3	1.946	1.395	1.16	5.8	1.675	1.255	1.41	12
ST_PI_4	1.892	1.94	1.06	2.4	2.125	1.682	0.348	13
ST_PI_5	1.825	0.91	0.51	9.4	1.302	0.813	2.58	11
ST_PI_6	0.79	0.79	0.79	0.79	-	-	0	1
ST_PI_7	2.8	2.8	2.8	2.8	-	-	0	1
ST_PI_8	12.3	12.3	12.3	12.3	-	-	0	1
ST_RIV_1	0.967	0.98	0.66	1.29	1.08	0.83	0.174	12
ST_RIV_10	0.922	1.005	0.14	1.12	1.06	0.9	0.266	12
ST_RIV_11	0.891	0.955	0.12	1.2	1.01	0.845	0.267	12
ST_RIV_12	0.873	0.88	0.01	1.23	1.04	0.835	0.305	12
ST_RIV_2	1.025	1.005	0.4	1.5	1.25	0.935	0.314	12
ST_RIV_3	1.515	1.1	0.78	5.5	1.525	0.905	1.297	12
ST_RIV_4	1.13	0.93	0.56	2.7	1.3	0.695	0.609	11
ST_RIV_5	1.14	1.1	0.9	1.44	1.278	1.022	0.18	13
ST_RIV_6	0.341	0.25	0.18	0.97	0.36	0.22	0.23	12
ST_RIV_7	0.39	0.33	0.14	0.77	0.608	0.233	0.22	11
ST_RIV_8	1.04	0.75	0.58	3.8	0.905	0.67	0.924	11

Summary statistics for Dissolved Reactive Phosphorus (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0.044	0.041	0.028	0.106	0.044	0.034	0.02	13
ST_DR_2	0.045	0.048	0.015	0.056	0.052	0.045	0.013	12
ST_DR_3	0.034	0.034	0.034	0.034	-	-	0	1
ST_DR_4	0.05	0.05	0.05	0.05	-	-	0	1
ST_DR_5	0.125	0.123	0.052	0.24	0.18	0.059	0.067	12
ST_DR_6	0.094	0.094	0.094	0.094	-	-	0	1
ST_DR_7	0.07	0.07	0.07	0.07	-	-	0	1
ST_EST_1	0.014	0.014	0.014	0.014	-	-	0	1
ST_EST_2	0.053	0.043	0.015	0.132	0.078	0.026	0.036	10
ST_PI_1	0.053	0.034	0.018	0.32	0.035	0.028	0.081	13
ST_PI_2	0.041	0.03	0.024	0.122	0.041	0.029	0.027	12
ST_PI_3	0.022	0.015	0.01	0.096	0.017	0.014	0.024	12
ST_PI_4	0.033	0.033	0.024	0.047	0.036	0.029	0.006	13
ST_PI_5	0.045	0.032	0.012	0.129	0.063	0.019	0.037	11
ST_PI_6	0.116	0.116	0.116	0.116	-	-	0	1
ST_PI_7	0.179	0.179	0.179	0.179	-	-	0	1
ST_PI_8	1.07	1.07	1.07	1.07	-	-	0	1
ST_RIV_1	0.027	0.025	0.012	0.046	0.027	0.024	0.008	12
ST_RIV_10	0.018	0.018	0.015	0.022	0.021	0.016	0.003	12
ST_RIV_11	0.013	0.013	0.009	0.016	0.015	0.01	0.003	12
ST_RIV_12	0.018	0.019	0.01	0.023	0.02	0.018	0.003	12
ST_RIV_2	0.023	0.013	0.007	0.05	0.037	0.011	0.016	12
ST_RIV_3	0.017	0.012	0.009	0.048	0.02	0.01	0.011	12
ST_RIV_4	0.018	0.012	0.01	0.056	0.018	0.011	0.014	11
ST_RIV_5	0.012	0.01	0.01	0.033	0.011	0.01	0.006	13
ST_RIV_6	0.011	0.006	0.004	0.068	0.009	0.004	0.018	12
ST_RIV_7	0.013	0.012	0.004	0.019	0.017	0.009	0.005	11
ST_RIV_8	0.021	0.016	0.011	0.053	0.026	0.012	0.013	11
ST_RIV_9	0.032	0.032	0.029	0.036	0.035	0.029	0.003	4

Summary statistics for Total Phosphorus (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0.055	0.048	0.033	0.182	0.052	0.035	0.039	13
ST_DR_2	0.115	0.099	0.075	0.23	0.117	0.085	0.049	12
ST_DR_3	0.106	0.106	0.106	0.106	-	-	0	1
ST_DR_4	0.079	0.079	0.079	0.079	-	-	0	1
ST_DR_5	0.373	0.285	0.129	1.49	0.36	0.205	0.363	12
ST_DR_6	0.185	0.185	0.185	0.185	-	-	0	1
ST_DR_7	0.128	0.128	0.128	0.128	-	-	0	1
ST_EST_1	0.043	0.043	0.043	0.043	-	-	0	1
ST_EST_2	0.11	0.097	0.05	0.21	0.14	0.062	0.056	10
ST_PI_1	0.201	0.044	0.026	1.45	0.131	0.041	0.392	13
ST_PI_2	0.149	0.064	0.039	1.08	0.08	0.058	0.294	12
ST_PI_3	0.051	0.022	0.014	0.3	0.041	0.018	0.08	12
ST_PI_4	0.06	0.038	0.03	0.27	0.049	0.031	0.065	13
ST_PI_5	0.306	0.058	0.02	2.6	0.139	0.035	0.763	11
ST_PI_6	0.156	0.156	0.156	0.156	-	-	0	1
ST_PI_7	0.94	0.94	0.94	0.94	-	-	0	1
ST_PI_8	1.29	1.29	1.29	1.29	-	-	0	1
ST_RIV_1	0.035	0.033	0.026	0.062	0.037	0.029	0.01	12
ST_RIV_10	0.025	0.022	0.018	0.041	0.028	0.021	0.007	12
ST_RIV_11	0.022	0.016	0.014	0.066	0.023	0.014	0.015	12
ST_RIV_12	0.022	0.022	0.017	0.025	0.024	0.021	0.002	12
ST_RIV_2	0.026	0.014	0.01	0.058	0.044	0.011	0.019	12
ST_RIV_3	0.021	0.017	0.01	0.049	0.026	0.012	0.012	12
ST_RIV_4	0.038	0.014	0.01	0.21	0.022	0.011	0.06	11
ST_RIV_5	0.014	0.012	0.009	0.04	0.013	0.01	0.008	13
ST_RIV_6	0.019	0.009	0.005	0.117	0.012	0.008	0.031	12
ST_RIV_7	0.023	0.02	0.011	0.065	0.025	0.014	0.015	11
ST_RIV_8	0.027	0.027	0.014	0.042	0.028	0.023	0.008	11
ST_RIV_9	0.211	0.235	0.063	0.31	0.285	0.137	0.107	4

APPENDIX 4

Summary Statistics for Metals

Summary statistics for Total Copper (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0.001	0.001	0.001	0.002	0.001	0.001	0	12
ST_DR_2	0.003	0.002	0.002	0.006	0.003	0.002	0.001	12
ST_DR_3	0.003	0.003	0.003	0.003	-	-	0	1
ST_DR_4	0.002	0.002	0.002	0.002	-	-	0	1
ST_DR_5	0.004	0.002	0.001	0.017	0.007	0.001	0.005	12
ST_DR_6	0.006	0.006	0.006	0.006	-	-	0	1
ST_DR_7	0.005	0.005	0.005	0.005	-	-	0	1
ST_EST_1	0.001	0.001	0.001	0.001	-	-	0	1
ST_EST_2	0.003	0.003	0.002	0.006	0.004	0.002	0.001	9
ST_PI_1	0.001	0.001	0.001	0.007	0.001	0.001	0.002	12
ST_PI_2	0.001	0.001	0.001	0.003	0.001	0.001	0.001	11
ST_PI_3	0.001	0.001	0.001	0.001	0.001	0.001	0	11
ST_PI_4	0.001	0.001	0.001	0.002	0.001	0.001	0	12
ST_PI_5	0.003	0.001	0.001	0.011	0.003	0.001	0.004	10
ST_PI_8	0.009	0.009	0.009	0.009	-	-	0	1
ST_RIV_1	0.008	0.001	0.001	0.091	0.001	0.001	0.026	12
ST_RIV_10	0.001	0.001	0.001	0.001	0.001	0.001	0	12
ST_RIV_11	0.001	0.001	0.001	0.007	0.001	0.001	0.002	12
ST_RIV_12	0.001	0.001	0.001	0.001	0.001	0.001	0	12
ST_RIV_2	0.001	0.001	0.001	0.002	0.001	0.001	0	12
ST_RIV_3	0.001	0.001	0.001	0.001	0.001	0.001	0	12
ST_RIV_4	0.001	0.001	0.001	0.001	0.001	0.001	0	11
ST_RIV_5	0.001	0.001	0.001	0.001	0.001	0.001	0	12
ST_RIV_6	0.001	0.001	0.001	0.002	0.001	0.001	0	12
ST_RIV_7	0.001	0.001	0.001	0.001	0.001	0.001	0	11
ST_RIV_8	0.001	0.001	0.001	0.001	0.001	0.001	0	11
ST_RIV_9	0.002	0.002	0.001	0.003	0.003	0.001	0.001	4

Summary statistics for Total Lead (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0	0	0	0.002	0	0	0	12
ST_DR_2	0.002	0.002	0.001	0.007	0.003	0.001	0.002	12
ST_DR_3	0.002	0.002	0.002	0.002	-	-	0	1
ST_DR_4	0.001	0.001	0.001	0.001	-	-	0	1
ST_DR_5	0.003	0.001	0	0.015	0.004	0.001	0.004	12
ST_DR_6	0.005	0.005	0.005	0.005	-	-	0	1
ST_DR_7	0.006	0.006	0.006	0.006	-	-	0	1
ST_EST_1	0	0	0	0	-	-	0	1
ST_EST_2	0.002	0.001	0.001	0.004	0.003	0.001	0.001	9
ST_PI_1	0.001	0	0	0.007	0	0	0.002	12
ST_PI_2	0	0	0	0.001	0	0	0	11
ST_PI_3	0	0	0	0.002	0	0	0	11
ST_PI_4	0	0	0	0.002	0	0	0.001	12
ST_PI_5	0.002	0.001	0	0.011	0.002	0	0.004	10
ST_PI_8	0.001	0.001	0.001	0.001	-	-	0	1
ST_RIV_1	0.001	0	0	0.005	0	0	0.001	12
ST_RIV_10	0	0	0	0	0	0	0	12
ST_RIV_11	0	0	0	0	0	0	0	12
ST_RIV_12	0	0	0	0	0	0	0	12
ST_RIV_2	0	0	0	0.001	0	0	0	12
ST_RIV_3	0	0	0	0.002	0	0	0	12
ST_RIV_4	0	0	0	0.001	0	0	0	11
ST_RIV_5	0	0	0	0	0	0	0	12
ST_RIV_6	0	0	0	0	0	0	0	12
ST_RIV_7	0	0	0	0	0	0	0	11
ST_RIV_8	0	0	0	0	0	0	0	11
ST_RIV_9	0.001	0.001	0	0.003	0.002	0.001	0.001	4

Summary statistics for Total Zinc (mg/L) (excluding first flush event)

Site ID	Mean	Median	Minimum	Maximum	75 percentile	25 percentile	Standard deviation (denom. = n-1)	Sample size
ST_DR_1	0.024	0.015	0.005	0.094	0.029	0.009	0.025	12
ST_DR_2	0.055	0.034	0.017	0.192	0.067	0.025	0.049	12
ST_DR_3	0.009	0.009	0.009	0.009	-	-	0	1
ST_DR_4	0.043	0.043	0.043	0.043	-	-	0	1
ST_DR_5	0.083	0.038	0.014	0.34	0.123	0.018	0.095	12
ST_DR_6	0.88	0.88	0.88	0.88	-	-	0	1
ST_DR_7	0.22	0.22	0.22	0.22	-	-	0	1
ST_EST_1	0.01	0.01	0.01	0.01	-	-	0	1
ST_EST_2	0.099	0.089	0.025	0.32	0.098	0.037	0.089	9
ST_PI_1	0.026	0.017	0.007	0.082	0.032	0.008	0.026	12
ST_PI_2	0.042	0.014	0.006	0.27	0.034	0.009	0.077	11
ST_PI_3	0.011	0.006	0.002	0.066	0.008	0.002	0.019	11
ST_PI_4	0.027	0.016	0.008	0.076	0.04	0.011	0.022	12
ST_PI_5	0.05	0.026	0.007	0.145	0.096	0.009	0.05	10
ST_PI_8	0.05	0.05	0.05	0.05	-	-	0	1
ST_RIV_1	0.009	0.001	0.001	0.061	0.002	0.001	0.019	12
ST_RIV_10	0.01	0.004	0.002	0.046	0.014	0.003	0.013	12
ST_RIV_11	0.004	0.003	0.001	0.019	0.005	0.002	0.005	12
ST_RIV_12	0.002	0.002	0.001	0.007	0.004	0.001	0.002	12
ST_RIV_2	0.024	0.011	0.002	0.077	0.046	0.002	0.027	12
ST_RIV_3	0.01	0.005	0.001	0.044	0.011	0.003	0.012	12
ST_RIV_4	0.007	0.001	0.001	0.056	0.002	0.001	0.017	11
ST_RIV_5	0.007	0.002	0.001	0.064	0.004	0.001	0.018	12
ST_RIV_6	0.007	0.001	0.001	0.071	0.001	0.001	0.02	12
ST_RIV_7	0.006	0.002	0.001	0.042	0.004	0.001	0.012	11
ST_RIV_8	0.011	0.007	0.002	0.041	0.014	0.003	0.012	11
ST_RIV_9	0.04	0.028	0.023	0.08	0.056	0.024	0.027	4

APPENDIX 5

Hill Laboratories Results Pesticides and TPH

Hill Laboratories
BETTER TESTING BETTER RESULTS

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ANALYSIS REPORT

Client:	Marlborough DC Surface Water & Air Quality	**Lab No:**	1297111 SPv1
Contact:	Steffi Henkel	**Date Registered:**	10-Jul-2014
	C/- Marlborough DC Surface Water & Air Quality	**Date Reported:**	23-Jul-2014
	C/- Marlborough District Council	**Quote No:**	52686
	PO Box 443	**Order No:**	50437SHE
	BLENHEIM 7240	**Client Reference:**	Taylor Stormwater on 9-Jul-2014
		Submitted By:	Steffi Henkel

Sample Type: Aqueous

Sample Name:		20142369 Alabama Road Drain at ALA-5 09-Jul-2014 1:20 pm	20142370 Doctors Creek Upstream Taylor 09-Jul-2014 11:35 am	20142371 Fultons Creek Upstream Taylor River 09-Jul-2014 12:10 pm	20142372 Fultons Creek at Nelson Street 09-Jul-2014 12:00 pm	20142373 Murphys Creek at MUR-2 09-Jul-2014 11:45 am
Lab Number:		1297111.1	1297111.2	1297111.3	1297111.4	1297111.5
Individual Tests						
pH	pH Units	7.5	7.6	7.5	7.7	7.2
Total Hardness	g/m³ as $CaCO_3$	94	62	41	51	47
Total Suspended Solids	g/m³	3	8	< 3	< 3	< 3
Dissolved Calcium	g/m³	25	16.5	11.4	13.6	13.5
Total Copper	g/m³	0.00121	0.091	0.00094	0.00145	0.00072
Total Lead	g/m³	0.00057	0.0048	0.00060	0.00034	0.00033
Dissolved Magnesium	g/m³	7.3	5.1	3.0	4.0	3.3
Total Zinc	g/m³	0.094	0.061	0.057	0.0076	0.056
Total Nitrogen	g/m³	5.3	1.29	0.98	1.60	1.32
Nitrite-N	g/m³	< 0.002	0.002	< 0.002	0.004	< 0.002
Nitrate-N	g/m³	5.1	1.02	0.88	1.43	1.18
Nitrate-N + Nitrite-N	g/m³	5.1	1.02	0.89	1.43	1.18
Total Kjeldahl Nitrogen (TKN)	g/m³	0.21	0.27	< 0.10	0.17	0.14
Dissolved Reactive Phosphorus	g/m³	0.028	0.024	0.012 #1	0.020	0.012 #1
Total Phosphorus	g/m³	0.034	0.028	0.010 #1	0.022	0.010 #1
Escherichia coli	cfu / 100mL	210	230	56	2,800	17

Sample Name:		20142374 Murphys Creek at MUR-6 09-Jul-2014 12:05 pm	20142375 Opawa Loop at OPL-5 09-Jul-2014 2:35 pm	20142376 Opawa Loop at OPL-6 09-Jul-2014 2:25 pm	20142377 Opawa River at OPR-50 09-Jul-2014 1:50 pm	20142378 Riverlands Coop Drain at RCD-1 09-Jul-2014 1:25 pm
Lab Number:		1297111.6	1297111.7	1297111.8	1297111.9	1297111.10
Individual Tests						
pH	pH Units	7.3	7.5	7.6	7.6	7.5
Total Hardness	g/m³ as $CaCO_3$	46	33	37	48	45
Total Suspended Solids	g/m³	< 3	6	4	5	53
Dissolved Calcium	g/m³	12.9	9.1	10.3	13.1	9.9
Total Copper	g/m³	< 0.00053	0.00181	< 0.00053	0.00061	0.0063
Total Lead	g/m³	0.00025	0.00044	0.00024	0.00035	0.0067
Dissolved Magnesium	g/m³	3.3	2.5	2.8	3.7	5.0
Total Zinc	g/m³	0.064	0.071	0.042	0.041	0.192
Total Nitrogen	g/m³	1.43	0.97	0.69	0.98	3.4
Nitrite-N	g/m³	< 0.002	< 0.002	0.003	0.002	0.008
Nitrate-N	g/m³	1.32	0.80	0.51	0.85	1.97
Nitrate-N + Nitrite-N	g/m³	1.32	0.80	0.51	0.85	1.98
Total Kjeldahl Nitrogen (TKN)	g/m³	0.11	0.17	0.18	0.13	1.46

Sample Type: Aqueous						
Sample Name:		20142374 Murphys Creek at MUR-6 09-Jul-2014 12:05 pm	20142375 Opawa Loop at OPL-5 09-Jul-2014 2:35 pm	20142376 Opawa Loop at OPL-6 09-Jul-2014 2:25 pm	20142377 Opawa River at OPR-50 09-Jul-2014 1:50 pm	20142378 Riverlands Coop Drain at RCD-1 09-Jul-2014 1:25 pm
Lab Number:		1297111.6	1297111.7	1297111.8	1297111.9	1297111.10
Individual Tests						
Dissolved Reactive Phosphorus	g/m³	0.010	0.010	0.012	0.016	0.056
Total Phosphorus	g/m³	0.012	0.012	0.014	0.020	0.198
Escherichia coli	cfu / 100mL	17	80 #2	90 #2	110 #2	4,400
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Acetochlor	g/m³	-	-	-	< 0.00005	-
Alachlor	g/m³	-	-	-	< 0.00005	-
Atrazine	g/m³	-	-	-	< 0.00005	-
Atrazine-desethyl	g/m³	-	-	-	< 0.00005	-
Atrazine-desisopropyl	g/m³	-	-	-	< 0.00010	-
Azaconazole	g/m³	-	-	-	< 0.00003	-
Azinphos-methyl	g/m³	-	-	-	< 0.00010	-
Benalaxyl	g/m³	-	-	-	< 0.00003	-
Bitertanol	g/m³	-	-	-	< 0.00010	-
Bromacil	g/m³	-	-	-	< 0.00005	-
Bromopropylate	g/m³	-	-	-	< 0.00005	-
Butachlor	g/m³	-	-	-	< 0.00005	-
Captan	g/m³	-	-	-	< 0.00010	-
Carbaryl	g/m³	-	-	-	< 0.00005	-
Carbofenothion	g/m³	-	-	-	< 0.00005	-
Carbofuran	g/m³	-	-	-	< 0.00005	-
Chlorfluazuron	g/m³	-	-	-	< 0.00005	-
Chlorothalonil	g/m³	-	-	-	< 0.00005	-
Chlorpyrifos	g/m³	-	-	-	< 0.00005	-
Chlorpyrifos-methyl	g/m³	-	-	-	< 0.00005	-
Chlortoluron	g/m³	-	-	-	< 0.00010	-
Cyanazine	g/m³	-	-	-	< 0.00005	-
Cyfluthrin	g/m³	-	-	-	< 0.00005	-
Cyhalothrin	g/m³	-	-	-	< 0.00005	-
Cypermethrin	g/m³	-	-	-	< 0.00010	-
Deltamethrin (including Tralomethrin)	g/m³	-	-	-	< 0.00006	-
Diazinon	g/m³	-	-	-	< 0.00003	-
Dichlofluanid	g/m³	-	-	-	< 0.00005	-
Dichloran	g/m³	-	-	-	< 0.0002	-
Dichlorvos	g/m³	-	-	-	< 0.00008	-
Difenoconazole	g/m³	-	-	-	< 0.00008	-
Dimethoate	g/m³	-	-	-	< 0.00010	-
Diphenylamine	g/m³	-	-	-	< 0.00010	-
Diuron	g/m³	-	-	-	< 0.00005	-
Fenpropimorph	g/m³	-	-	-	< 0.00005	-
Fluazifop-butyl	g/m³	-	-	-	< 0.00005	-
Fluometuron	g/m³	-	-	-	< 0.00005	-
Flusilazole	g/m³	-	-	-	< 0.00005	-
Fluvalinate	g/m³	-	-	-	< 0.00004	-
Furalaxyl	g/m³	-	-	-	< 0.00003	-
Haloxyfop-methyl	g/m³	-	-	-	< 0.00005	-
Hexaconazole	g/m³	-	-	-	< 0.00005	-
Hexazinone	g/m³	-	-	-	< 0.00003	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m³	-	-	-	< 0.0003	-
Kresoxim-methyl	g/m³	-	-	-	< 0.00003	-
Linuron	g/m³	-	-	-	< 0.00005	-
Malathion	g/m³	-	-	-	< 0.00005	-
Metalaxyl	g/m³	-	-	-	< 0.00005	-

Sample Type: Aqueous						
Sample Name:		20142374 Murphys Creek at MUR-6 09-Jul-2014 12:05 pm	20142375 Opawa Loop at OPL-5 09-Jul-2014 2:35 pm	20142376 Opawa Loop at OPL-6 09-Jul-2014 2:25 pm	20142377 Opawa River at OPR-50 09-Jul-2014 1:50 pm	20142378 Riverlands Coop Drain at RCD-1 09-Jul-2014 1:25 pm
Lab Number:		1297111.6	1297111.7	1297111.8	1297111.9	1297111.10
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Metolachlor	g/m³	-	-	-	< 0.00004	-
Metribuzin	g/m³	-	-	-	< 0.00005	-
Molinate	g/m³	-	-	-	< 0.00008	-
Myclobutanil	g/m³	-	-	-	< 0.00005	-
Naled	g/m³	-	-	-	< 0.0003	-
Norflurazon	g/m³	-	-	-	< 0.00010	-
Oxadiazon	g/m³	-	-	-	< 0.00005	-
Oxyfluorfen	g/m³	-	-	-	< 0.00003	-
Paclobutrazol	g/m³	-	-	-	< 0.00005	-
Parathion-ethyl	g/m³	-	-	-	< 0.00005	-
Parathion-methyl	g/m³	-	-	-	< 0.00005	-
Pendimethalin	g/m³	-	-	-	< 0.00005	-
Permethrin	g/m³	-	-	-	< 0.00002	-
Pirimicarb	g/m³	-	-	-	< 0.00005	-
Pirimiphos-methyl	g/m³	-	-	-	< 0.00005	-
Prochloraz	g/m³	-	-	-	< 0.0003	-
Procymidone	g/m³	-	-	-	< 0.00005	-
Prometryn	g/m³	-	-	-	< 0.00003	-
Propachlor	g/m³	-	-	-	< 0.00005	-
Propanil	g/m³	-	-	-	< 0.0002	-
Propazine	g/m³	-	-	-	< 0.00003	-
Propiconazole	g/m³	-	-	-	< 0.00004	-
Pyriproxyfen	g/m³	-	-	-	< 0.00005	-
Quizalofop-ethyl	g/m³	-	-	-	< 0.00005	-
Simazine	g/m³	-	-	-	< 0.00005	-
Simetryn	g/m³	-	-	-	< 0.00005	-
Sulfentrazone	g/m³	-	-	-	< 0.0003	-
TCMTB [2-(thiocyanomethylthio) benzothiazole,Busan]	g/m³	-	-	-	< 0.00010	-
Tebuconazole	g/m³	-	-	-	< 0.00005	-
Terbacil	g/m³	-	-	-	< 0.00005	-
Terbumeton	g/m³	-	-	-	< 0.00005	-
Terbuthylazine	g/m³	-	-	-	< 0.00003	-
Terbuthylazine-desethyl	g/m³	-	-	-	< 0.00005	-
Terbutryn	g/m³	-	-	-	< 0.00005	-
Thiabendazole	g/m³	-	-	-	< 0.0003	-
Thiobencarb	g/m³	-	-	-	< 0.00005	-
Tolylfluanid	g/m³	-	-	-	< 0.00003	-
Triazophos	g/m³	-	-	-	< 0.00005	-
Trifluralin	g/m³	-	-	-	< 0.00005	-
Vinclozolin	g/m³	-	-	-	< 0.00005	-
Organochlorine Pesticides Trace in water, By Liq/Liq						
Aldrin	g/m³	-	-	-	< 0.000005	-
alpha-BHC	g/m³	-	-	-	< 0.000010	-
beta-BHC	g/m³	-	-	-	< 0.000010	-
delta-BHC	g/m³	-	-	-	< 0.000010	-
gamma-BHC (Lindane)	g/m³	-	-	-	< 0.000010	-
cis-Chlordane	g/m³	-	-	-	< 0.000005	-
trans-Chlordane	g/m³	-	-	-	< 0.000005	-
2,4'-DDD	g/m³	-	-	-	< 0.000010	-
4,4'-DDD	g/m³	-	-	-	< 0.000010	-
2,4'-DDE	g/m³	-	-	-	< 0.000010	-
4,4'-DDE	g/m³	-	-	-	< 0.000010	-

Sample Type: Aqueous						
Sample Name:		20142374 Murphys Creek at MUR-6 09-Jul-2014 12:05 pm	20142375 Opawa Loop at OPL-5 09-Jul-2014 2:35 pm	20142376 Opawa Loop at OPL-6 09-Jul-2014 2:25 pm	20142377 Opawa River at OPR-50 09-Jul-2014 1:50 pm	20142378 Riverlands Coop Drain at RCD-1 09-Jul-2014 1:25 pm
Lab Number:		1297111.6	1297111.7	1297111.8	1297111.9	1297111.10
Organochlorine Pesticides Trace in water, By Liq/Liq						
2,4'-DDT	g/m³	-	-	-	< 0.000010	-
4,4'-DDT	g/m³	-	-	-	< 0.000010	-
Dieldrin	g/m³	-	-	-	< 0.000005	-
Endosulfan I	g/m³	-	-	-	< 0.000010	-
Endosulfan II	g/m³	-	-	-	< 0.000010	-
Endosulfan sulfate	g/m³	-	-	-	< 0.000010	-
Endrin	g/m³	-	-	-	< 0.000005	-
Endrin aldehyde	g/m³	-	-	-	< 0.000005	-
Endrin ketone	g/m³	-	-	-	< 0.000010	-
Heptachlor	g/m³	-	-	-	< 0.000005	-
Heptachlor epoxide	g/m³	-	-	-	< 0.000005	-
Hexachlorobenzene	g/m³	-	-	-	< 0.00004	-
Methoxychlor	g/m³	-	-	-	< 0.000005	-
Total Chlordane [(cis+trans)*100/42]	g/m³	-	-	-	< 0.00002	-
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	-	< 0.000008	-
Acenaphthylene	g/m³	-	-	-	< 0.000008	-
Anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]pyrene (BAP)	g/m³	-	-	-	< 0.000008	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	-	< 0.000008	-
Benzo[g,h,i]perylene	g/m³	-	-	-	< 0.000008	-
Benzo[k]fluoranthene	g/m³	-	-	-	< 0.000008	-
Chrysene	g/m³	-	-	-	< 0.000008	-
Dibenzo[a,h]anthracene	g/m³	-	-	-	< 0.000008	-
Fluoranthene	g/m³	-	-	-	< 0.000008	-
Fluorene	g/m³	-	-	-	< 0.000008	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	-	< 0.000008	-
Naphthalene	g/m³	-	-	-	< 0.00004	-
Phenanthrene	g/m³	-	-	-	< 0.000008	-
Pyrene	g/m³	-	-	-	< 0.000008	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	-	-	-	< 0.10	-
C10 - C14	g/m³	-	-	-	< 0.2	-
C15 - C36	g/m³	-	-	-	< 0.4	-
Total hydrocarbons (C7 - C36)	g/m³	-	-	-	< 0.7	-

Sample Name:		20142379 Pipe at STW-14 09-Jul-2014 2:20 pm	20142380 Pipe at STW-15 09-Jul-2014 2:15 pm	20142381 Pipe at STW-16 09-Jul-2014 12:25 pm	20142382 Pipe at STW-17 09-Jul-2014 11:30 am	20142384 Town Branch Drain at TBD-1 09-Jul-2014 1:35 pm
Lab Number:		1297111.11	1297111.12	1297111.13	1297111.14	1297111.15
Individual Tests						
pH	pH Units	7.5	7.5	7.3	7.4	7.9
Total Hardness	g/m³ as $CaCO_3$	54	70	55	67	125
Total Suspended Solids	g/m³	11	8	< 3	5	490
Dissolved Calcium	g/m³	14.6	18.0	15.1	17.7	30
Total Copper	g/m³	0.00085	0.00074	< 0.00053	0.00159	0.0099
Total Lead	g/m³	0.00030	0.00033	0.00018	0.0021	0.0050
Dissolved Magnesium	g/m³	4.3	6.1	4.2	5.6	12.2
Total Zinc	g/m³	0.0069	0.048	0.066	0.045	0.138
Total Nitrogen	g/m³	1.12	1.22	1.44	1.94	3.7

Sample Type: Aqueous						
Sample Name:		20142379 Pipe at STW-14 09-Jul-2014 2:20 pm	20142380 Pipe at STW-15 09-Jul-2014 2:15 pm	20142381 Pipe at STW-16 09-Jul-2014 12:25 pm	20142382 Pipe at STW-17 09-Jul-2014 11:30 am	20142384 Town Branch Drain at TBD-1 09-Jul-2014 1:35 pm
Lab Number:		1297111.11	1297111.12	1297111.13	1297111.14	1297111.15
Individual Tests						
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	0.002	0.035
Nitrate-N	g/m³	0.93	1.00	1.31	1.76	1.83
Nitrate-N + Nitrite-N	g/m³	0.93	1.00	1.31	1.76	1.87
Total Kjeldahl Nitrogen (TKN)	g/m³	0.18	0.22	0.13	0.18	1.86
Dissolved Reactive Phosphorus	g/m³	0.019	0.024	0.015	0.029	0.066
Total Phosphorus	g/m³	0.026	0.058	0.016	0.030	0.23
Escherichia coli	cfu / 100mL	120	140 #2	100 #2	150 #2	< 100 #2
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	< 0.000008	-	-	-
Acenaphthylene	g/m³	-	< 0.000008	-	-	-
Anthracene	g/m³	-	< 0.000008	-	-	-
Benzo[a]anthracene	g/m³	-	< 0.000008	-	-	-
Benzo[a]pyrene (BAP)	g/m³	-	< 0.000008	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	< 0.000008	-	-	-
Benzo[g,h,i]perylene	g/m³	-	< 0.000008	-	-	-
Benzo[k]fluoranthene	g/m³	-	< 0.000008	-	-	-
Chrysene	g/m³	-	< 0.000008	-	-	-
Dibenzo[a,h]anthracene	g/m³	-	< 0.000008	-	-	-
Fluoranthene	g/m³	-	< 0.000008	-	-	-
Fluorene	g/m³	-	< 0.000008	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	< 0.000008	-	-	-
Naphthalene	g/m³	-	< 0.00004	-	-	-
Phenanthrene	g/m³	-	< 0.000008	-	-	-
Pyrene	g/m³	-	0.000009	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	-	< 0.10	-	-	-
C10 - C14	g/m³	-	< 0.2	-	-	-
C15 - C36	g/m³	-	< 0.4	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	-	< 0.7	-	-	-

Sample Name:		20142385 Taylor River at Rail Bridge 09-Jul-2014 2:10 pm	20142386 Taylor River at TYR-22 09-Jul-2014 12:20 pm	20142387 Yelverton Stream Upstream Doctors Creek 09-Jul-2014 11:35 am	20142388 Wither Stream upstream Sutherland Stm 09-Jul-2014 1:00 pm	20142398 Riverlands Coop/Sutherland Stream 09-Jul-2014 1:10 pm
Lab Number:		1297111.16	1297111.17	1297111.18	1297111.19	1297111.20
Individual Tests						
pH	pH Units	7.5	7.5	7.6	7.6	7.4
Total Hardness	g/m³ as $CaCO_3$	53	49	54	42	31
Total Suspended Solids	g/m³	4	7	5	21	33
Dissolved Calcium	g/m³	14.2	13.5	15.0	9.8	7.4
Total Copper	g/m³	0.00059	0.00071	0.00116	0.0056	0.0052
Total Lead	g/m³	0.00021	0.00039	0.00035	0.0044	0.0058
Dissolved Magnesium	g/m³	4.2	3.8	4.1	4.2	3.1
Total Zinc	g/m³	0.046	0.0188	0.0054	0.32	0.22
Total Nitrogen	g/m³	1.12	1.20	1.23	2.5	1.95
Nitrite-N	g/m³	< 0.002	< 0.002	0.003	0.010	0.009
Nitrate-N	g/m³	0.97	1.07	1.08	1.56	1.07
Nitrate-N + Nitrite-N	g/m³	0.97	1.07	1.08	1.57	1.08
Total Kjeldahl Nitrogen (TKN)	g/m³	0.15	0.13	0.15	0.96	0.87
Dissolved Reactive Phosphorus	g/m³	0.018	0.015	0.018	0.064	0.070
Total Phosphorus	g/m³	0.020	0.066	0.022	0.140	0.128
Escherichia coli	cfu / 100mL	140 #2	60	210	410	1,400

Sample Type: Aqueous						
Sample Name:		20142385 Taylor River at Rail Bridge 09-Jul-2014 2:10 pm	20142386 Taylor River at TYR-22 09-Jul-2014 12:20 pm	20142387 Yelverton Stream Upstream Doctors Creek 09-Jul-2014 11:35 am	20142388 Wither Stream upstream Sutherland Stm 09-Jul-2014 1:00 pm	20142398 Riverlands Coop/Sutherland Stream 09-Jul-2014 1:10 pm
Lab Number:		1297111.16	1297111.17	1297111.18	1297111.19	1297111.20
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Acetochlor	g/m³	< 0.00004	-	-	-	-
Alachlor	g/m³	< 0.00004	-	-	-	-
Atrazine	g/m³	< 0.00004	-	-	-	-
Atrazine-desethyl	g/m³	< 0.00004	-	-	-	-
Atrazine-desisopropyl	g/m³	< 0.00008	-	-	-	-
Azaconazole	g/m³	< 0.00002	-	-	-	-
Azinphos-methyl	g/m³	< 0.00008	-	-	-	-
Benalaxyl	g/m³	< 0.00002	-	-	-	-
Bitertanol	g/m³	< 0.00008	-	-	-	-
Bromacil	g/m³	< 0.00004	-	-	-	-
Bromopropylate	g/m³	< 0.00004	-	-	-	-
Butachlor	g/m³	< 0.00004	-	-	-	-
Captan	g/m³	< 0.00008	-	-	-	-
Carbaryl	g/m³	< 0.00004	-	-	-	-
Carbofenothion	g/m³	< 0.00004	-	-	-	-
Carbofuran	g/m³	< 0.00004	-	-	-	-
Chlorfluazuron	g/m³	< 0.00004	-	-	-	-
Chlorothalonil	g/m³	< 0.00004	-	-	-	-
Chlorpyrifos	g/m³	< 0.00004	-	-	-	-
Chlorpyrifos-methyl	g/m³	< 0.00004	-	-	-	-
Chlortoluron	g/m³	< 0.00008	-	-	-	-
Cyanazine	g/m³	< 0.00004	-	-	-	-
Cyfluthrin	g/m³	< 0.00004	-	-	-	-
Cyhalothrin	g/m³	< 0.00004	-	-	-	-
Cypermethrin	g/m³	< 0.00008	-	-	-	-
Deltamethrin (including Tralomethrin)	g/m³	< 0.00006	-	-	-	-
Diazinon	g/m³	< 0.00002	-	-	-	-
Dichlofluanid	g/m³	< 0.00004	-	-	-	-
Dichloran	g/m³	< 0.0002	-	-	-	-
Dichlorvos	g/m³	< 0.00008	-	-	-	-
Difenoconazole	g/m³	< 0.00008	-	-	-	-
Dimethoate	g/m³	< 0.00008	-	-	-	-
Diphenylamine	g/m³	< 0.00008	-	-	-	-
Diuron	g/m³	< 0.00004	-	-	-	-
Fenpropimorph	g/m³	< 0.00004	-	-	-	-
Fluazifop-butyl	g/m³	< 0.00004	-	-	-	-
Fluometuron	g/m³	< 0.00004	-	-	-	-
Flusilazole	g/m³	< 0.00004	-	-	-	-
Fluvalinate	g/m³	< 0.00004	-	-	-	-
Furalaxyl	g/m³	< 0.00002	-	-	-	-
Haloxyfop-methyl	g/m³	< 0.00004	-	-	-	-
Hexaconazole	g/m³	< 0.00004	-	-	-	-
Hexazinone	g/m³	< 0.00002	-	-	-	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m³	< 0.0002	-	-	-	-
Kresoxim-methyl	g/m³	< 0.00002	-	-	-	-
Linuron	g/m³	< 0.00005	-	-	-	-
Malathion	g/m³	< 0.00004	-	-	-	-
Metalaxyl	g/m³	< 0.00004	-	-	-	-
Metolachlor	g/m³	< 0.00004	-	-	-	-
Metribuzin	g/m³	< 0.00004	-	-	-	-
Molinate	g/m³	< 0.00008	-	-	-	-

Sample Type: Aqueous						
Sample Name:		20142385 Taylor River at Rail Bridge 09-Jul-2014 2:10 pm	20142386 Taylor River at TYR-22 09-Jul-2014 12:20 pm	20142387 Yelverton Stream Upstream Doctors Creek 09-Jul-2014 11:35 am	20142388 Wither Stream upstream Sutherland Stm 09-Jul-2014 1:00 pm	20142398 Riverlands Coop/Sutherland Stream 09-Jul-2014 1:10 pm
Lab Number:		1297111.16	1297111.17	1297111.18	1297111.19	1297111.20
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Myclobutanil	g/m³	< 0.00004	-	-	-	-
Naled	g/m³	< 0.0002	-	-	-	-
Norflurazon	g/m³	< 0.00008	-	-	-	-
Oxadiazon	g/m³	< 0.00004	-	-	-	-
Oxyfluorfen	g/m³	< 0.00002	-	-	-	-
Paclobutrazol	g/m³	< 0.00004	-	-	-	-
Parathion-ethyl	g/m³	< 0.00004	-	-	-	-
Parathion-methyl	g/m³	< 0.00004	-	-	-	-
Pendimethalin	g/m³	< 0.00004	-	-	-	-
Permethrin	g/m³	< 0.00002	-	-	-	-
Pirimicarb	g/m³	< 0.00004	-	-	-	-
Pirimiphos-methyl	g/m³	< 0.00004	-	-	-	-
Prochloraz	g/m³	< 0.0002	-	-	-	-
Procymidone	g/m³	< 0.00004	-	-	-	-
Prometryn	g/m³	< 0.00002	-	-	-	-
Propachlor	g/m³	< 0.00004	-	-	-	-
Propanil	g/m³	< 0.0002	-	-	-	-
Propazine	g/m³	< 0.00002	-	-	-	-
Propiconazole	g/m³	< 0.00004	-	-	-	-
Pyriproxyfen	g/m³	< 0.00004	-	-	-	-
Quizalofop-ethyl	g/m³	< 0.00004	-	-	-	-
Simazine	g/m³	< 0.00004	-	-	-	-
Simetryn	g/m³	< 0.00004	-	-	-	-
Sulfentrazone	g/m³	< 0.0002	-	-	-	-
TCMTB [2-(thiocyanomethylthio) benzothiazole,Busan]	g/m³	< 0.00008	-	-	-	-
Tebuconazole	g/m³	< 0.00004	-	-	-	-
Terbacil	g/m³	< 0.00004	-	-	-	-
Terbumeton	g/m³	< 0.00004	-	-	-	-
Terbuthylazine	g/m³	< 0.00002	-	-	-	-
Terbuthylazine-desethyl	g/m³	< 0.00004	-	-	-	-
Terbutryn	g/m³	< 0.00004	-	-	-	-
Thiabendazole	g/m³	< 0.0002	-	-	-	-
Thiobencarb	g/m³	< 0.00004	-	-	-	-
Tolylfluanid	g/m³	< 0.00002	-	-	-	-
Triazophos	g/m³	< 0.00004	-	-	-	-
Trifluralin	g/m³	< 0.00004	-	-	-	-
Vinclozolin	g/m³	< 0.00004	-	-	-	-
Organochlorine Pesticides Trace in water, By Liq/Liq						
Aldrin	g/m³	< 0.000005	-	-	-	-
alpha-BHC	g/m³	< 0.000010	-	-	-	-
beta-BHC	g/m³	< 0.000010	-	-	-	-
delta-BHC	g/m³	< 0.000010	-	-	-	-
gamma-BHC (Lindane)	g/m³	< 0.000010	-	-	-	-
cis-Chlordane	g/m³	< 0.000005	-	-	-	-
trans-Chlordane	g/m³	< 0.000005	-	-	-	-
2,4'-DDD	g/m³	< 0.000010	-	-	-	-
4,4'-DDD	g/m³	< 0.000010	-	-	-	-
2,4'-DDE	g/m³	< 0.000010	-	-	-	-
4,4'-DDE	g/m³	< 0.000010	-	-	-	-
2,4'-DDT	g/m³	< 0.000010	-	-	-	-
4,4'-DDT	g/m³	< 0.000010	-	-	-	-

Sample Type: Aqueous						
Sample Name:		20142385 Taylor River at Rail Bridge 09-Jul-2014 2:10 pm	20142386 Taylor River at TYR-22 09-Jul-2014 12:20 pm	20142387 Yelverton Stream Upstream Doctors Creek 09-Jul-2014 11:35 am	20142388 Wither Stream upstream Sutherland Stm 09-Jul-2014 1:00 pm	20142398 Riverlands Coop/Sutherland Stream 09-Jul-2014 1:10 pm
Lab Number:		1297111.16	1297111.17	1297111.18	1297111.19	1297111.20
Organochlorine Pesticides Trace in water, By Liq/Liq						
Dieldrin	g/m³	< 0.000005	-	-	-	-
Endosulfan I	g/m³	< 0.000010	-	-	-	-
Endosulfan II	g/m³	< 0.000010	-	-	-	-
Endosulfan sulfate	g/m³	< 0.000010	-	-	-	-
Endrin	g/m³	< 0.000005	-	-	-	-
Endrin aldehyde	g/m³	< 0.000005	-	-	-	-
Endrin ketone	g/m³	< 0.000010	-	-	-	-
Heptachlor	g/m³	< 0.000005	-	-	-	-
Heptachlor epoxide	g/m³	< 0.000005	-	-	-	-
Hexachlorobenzene	g/m³	< 0.00004	-	-	-	-
Methoxychlor	g/m³	< 0.000005	-	-	-	-
Total Chlordane [(cis+trans)*100/42]	g/m³	< 0.00002	-	-	-	-
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	< 0.000008	-	-	-
Acenaphthylene	g/m³	-	< 0.000008	-	-	-
Anthracene	g/m³	-	< 0.000008	-	-	-
Benzo[a]anthracene	g/m³	-	< 0.000008	-	-	-
Benzo[a]pyrene (BAP)	g/m³	-	< 0.000008	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	< 0.000008	-	-	-
Benzo[g,h,i]perylene	g/m³	-	< 0.000008	-	-	-
Benzo[k]fluoranthene	g/m³	-	< 0.000008	-	-	-
Chrysene	g/m³	-	< 0.000008	-	-	-
Dibenzo[a,h]anthracene	g/m³	-	< 0.000008	-	-	-
Fluoranthene	g/m³	-	< 0.000008	-	-	-
Fluorene	g/m³	-	< 0.000008	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	< 0.000008	-	-	-
Naphthalene	g/m³	-	< 0.00004	-	-	-
Phenanthrene	g/m³	-	< 0.000008	-	-	-
Pyrene	g/m³	-	< 0.000008	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	-	< 0.10	-	-	-
C10 - C14	g/m³	-	< 0.2	-	-	-
C15 - C36	g/m³	-	< 0.4	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	-	< 0.7	-	-	-

Analyst's Comments

It has been noted that the method performance for Terbufos and Iprodione for ONOP analysis is not acceptable, therefore we are unable to report these compounds at this present time.
Due to in-house QC failure in the original extraction of sample 1297111.9 for ONOP analysis, the re-extraction was done on a limited sample volume. Hence the higher detection limits reported.

#1 It has been noted that the result for Dissolved Reactive Phosphorus was greater than that for Total Phosphorus, but within the analytical variation of these methods.

#2 Statistically estimated count based on the theoretical countable range for the stated method.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Organochlorine/Organonitro&phosphorus Pest.s Trace in Water	Liquid / liquid extraction, GPC (if required), GC-MS analysis	-	9, 16

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis [KBIs:4736,2695]	0.000005 g/m³	9, 12, 17
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m³	9, 12, 17
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter. Performed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch.	-	1-20
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-20
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1-20
Total Phosphorus Digestion	Acid persulphate digestion.	-	1-20
pH	pH meter. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1-20
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-20
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 2540 D 22nd ed. 2012.	3 g/m³	1-20
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-20
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m³	1-20
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m³	1-20
Total Lead	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00011 g/m³	1-20
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-20
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.0011 g/m³	1-20
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m³ is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m³, the Default Detection Limit for Total Nitrogen will be 0.11 g/m³.	0.05 g/m³	1-20
Nitrite-N	Filtered sample from Christchurch. Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-20
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m³	1-20
Nitrate-N + Nitrite-N	Filtered sample from Christchurch. Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-20
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1-20
Dissolved Reactive Phosphorus	Filtered sample from Christchurch. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m³	1-20
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P B & E (modified from manual analysis) 22nd ed. 2012. Also modified to include the use of a reductant to eliminate interference from arsenic present in the sample. NWASCA, Water & soil Miscellaneous Publication No. 38, 1982.	0.004 g/m³	1-20
Escherichia coli	Membrane filtration, Count on mFC agar, Incubated at 44.5°C for 22 hours, MUG Confirmation Analysed at Hill Laboratories - Microbiology; 101c Waterloo Road, Hornby, Christchurch. APHA 9222 G, 22nd ed. 2012.	1 cfu / 100mL	1-20

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Marlborough District Council	**Lab No:**	1214754 SPv1
Contact:	Steffi Henkel	**Date Registered:**	12-Dec-2013
	C/- Marlborough DC Surface Water & Air Quality	**Date Reported:**	23-Dec-2013
	C/- Marlborough District Council	**Quote No:**	52686
	PO Box 443	**Order No:**	46354CVO
	BLENHEIM 7240	**Client Reference:**	Taylor Stormwater on 11-Dec
		Submitted By:	Steffi Henkel

Sample Type: Aqueous

		Sample Name:	20131744 11-Dec-2013 9:15 am	20131745 11-Dec-2013 12:51 pm	20131746 11-Dec-2013 11:41 am	20131747 11-Dec-2013 11:54 am	20131748 11-Dec-2013 12:43 pm
		Lab Number:	1214754.1	1214754.2	1214754.3	1214754.4	1214754.5
Individual Tests							
pH	pH Units		7.3	7.5	7.3	7.3	7.0
Total Hardness	g/m³ as $CaCO_3$		94	66	44	56	42
Total Suspended Solids	g/m³		< 3	5	5	< 3	< 3
Dissolved Calcium	g/m³		25	17.5	12.4	15.3	11.9
Total Copper	g/m³		0.00086	0.00066	< 0.00053	< 0.00053	< 0.00053
Total Lead	g/m³		0.00014	0.00015	0.00021	0.00020	< 0.00011
Dissolved Magnesium	g/m³		7.5	5.4	3.3	4.2	3.1
Total Zinc	g/m³		0.0050	< 0.0011	0.0015	0.0044	< 0.0011
Total Nitrogen	g/m³		4.1	0.84	0.89	1.29	0.56
Nitrite-N	g/m³		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate-N	g/m³		3.9	0.69	0.77	1.16	0.52
Nitrate-N + Nitrite-N	g/m³		3.9	0.69	0.78	1.17	0.52
Total Kjeldahl Nitrogen (TKN)	g/m³		0.19	0.15	0.12	0.12	< 0.10
Dissolved Reactive Phosphorus	g/m³		0.035 #2	0.022	0.007	0.010	0.012
Total Phosphorus	g/m³		0.033 #2	0.028	0.011	0.018	0.013
Escherichia coli	cfu / 100mL		1,200 #1	370 #3	210 #3	600 #1	260 #3

		Sample Name:	20131749 11-Dec-2013 12:21 pm	20131750 11-Dec-2013 11:05 am	20131751 11-Dec-2013 11:15 am	20131752 11-Dec-2013 9:53 am	20131753 11-Dec-2013 9:57 am
		Lab Number:	1214754.6	1214754.7	1214754.8	1214754.9	1214754.10
Individual Tests							
pH	pH Units		7.1	7.2	7.3	7.3	7.4
Total Hardness	g/m³ as $CaCO_3$		47	31	32	47	58
Total Suspended Solids	g/m³		< 3	< 3	11	< 3	76
Dissolved Calcium	g/m³		13.3	8.5	8.8	12.9	15.4
Total Copper	g/m³		< 0.00053	< 0.00053	< 0.00053	< 0.00053	0.0034
Total Lead	g/m³		< 0.00011	< 0.00011	< 0.00011	< 0.00011	0.0027
Dissolved Magnesium	g/m³		3.5	2.3	2.4	3.7	4.7
Total Zinc	g/m³		< 0.0011	< 0.0011	0.0012	0.0015	0.031
Total Nitrogen	g/m³		0.90	0.25	0.35	0.70	1.64
Nitrite-N	g/m³		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate-N	g/m³		0.83	0.18	0.11	0.56	0.42
Nitrate-N + Nitrite-N	g/m³		0.83	0.18	0.11	0.56	0.43
Total Kjeldahl Nitrogen (TKN)	g/m³		< 0.10	< 0.10	0.24	0.14	1.22
Dissolved Reactive Phosphorus	g/m³		0.010	0.006	0.009	0.017	0.029
Total Phosphorus	g/m³		0.010	0.009	0.065	0.028	0.26
Escherichia coli	cfu / 100mL		140 #1	120 #1	110 #1	220 #3	220 #3

Sample Type: Aqueous						
Sample Name:		20131749 11-Dec-2013 12:21 pm	20131750 11-Dec-2013 11:05 am	20131751 11-Dec-2013 11:15 am	20131752 11-Dec-2013 9:53 am	20131753 11-Dec-2013 9:57 am
Lab Number:		1214754.6	1214754.7	1214754.8	1214754.9	1214754.10
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Acetochlor	g/m³	-	-	-	-	< 0.00004
Alachlor	g/m³	-	-	-	-	< 0.00004
Atrazine	g/m³	-	-	-	-	< 0.00004
Atrazine-desethyl	g/m³	-	-	-	-	< 0.00004
Atrazine-desisopropyl	g/m³	-	-	-	-	< 0.00008
Azaconazole	g/m³	-	-	-	-	< 0.00002
Azinphos-methyl	g/m³	-	-	-	-	< 0.00008
Benalaxyl	g/m³	-	-	-	-	< 0.00002
Bitertanol	g/m³	-	-	-	-	< 0.00008
Bromacil	g/m³	-	-	-	-	< 0.00004
Bromopropylate	g/m³	-	-	-	-	< 0.00004
Butachlor	g/m³	-	-	-	-	< 0.00004
Captan	g/m³	-	-	-	-	< 0.00008
Carbaryl	g/m³	-	-	-	-	< 0.00004
Carbofenothion	g/m³	-	-	-	-	< 0.00004
Carbofuran	g/m³	-	-	-	-	< 0.00004
Chlorfluazuron	g/m³	-	-	-	-	< 0.00004
Chlorothalonil	g/m³	-	-	-	-	< 0.00004
Chlorpyrifos	g/m³	-	-	-	-	< 0.00004
Chlorpyrifos-methyl	g/m³	-	-	-	-	< 0.00004
Chlortoluron	g/m³	-	-	-	-	< 0.00008
Cyanazine	g/m³	-	-	-	-	< 0.00004
Cyfluthrin	g/m³	-	-	-	-	< 0.00004
Cyhalothrin	g/m³	-	-	-	-	< 0.00004
Cypermethrin	g/m³	-	-	-	-	< 0.00008
Deltamethrin	g/m³	-	-	-	-	< 0.00006
Diazinon	g/m³	-	-	-	-	< 0.00002
Dichlofluanid	g/m³	-	-	-	-	< 0.00004
Dichloran	g/m³	-	-	-	-	< 0.0002
Dichlorvos	g/m³	-	-	-	-	< 0.00008
Difenoconazole	g/m³	-	-	-	-	< 0.00008
Dimethoate	g/m³	-	-	-	-	< 0.00008
Diphenylamine	g/m³	-	-	-	-	< 0.00008
Diuron	g/m³	-	-	-	-	< 0.00004
Fenpropimorph	g/m³	-	-	-	-	< 0.00004
Fluazifop-butyl	g/m³	-	-	-	-	< 0.00004
Fluometuron	g/m³	-	-	-	-	< 0.00004
Flusilazole	g/m³	-	-	-	-	< 0.00004
Fluvalinate	g/m³	-	-	-	-	< 0.00004
Furalaxyl	g/m³	-	-	-	-	< 0.00002
Haloxyfop-methyl	g/m³	-	-	-	-	< 0.00004
Hexaconazole	g/m³	-	-	-	-	< 0.00004
Hexazinone	g/m³	-	-	-	-	< 0.00002
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m³	-	-	-	-	< 0.0002
Kresoxim-methyl	g/m³	-	-	-	-	< 0.00002
Linuron	g/m³	-	-	-	-	< 0.00005
Malathion	g/m³	-	-	-	-	< 0.00004
Metalaxyl	g/m³	-	-	-	-	< 0.00004
Metolachlor	g/m³	-	-	-	-	< 0.00004
Metribuzin	g/m³	-	-	-	-	< 0.00004
Molinate	g/m³	-	-	-	-	< 0.00008
Myclobutanil	g/m³	-	-	-	-	< 0.00004
Naled	g/m³	-	-	-	-	< 0.0002
Norflurazon	g/m³	-	-	-	-	< 0.00008

Sample Type: Aqueous						
Sample Name:		20131749 11-Dec-2013 12:21 pm	20131750 11-Dec-2013 11:05 am	20131751 11-Dec-2013 11:15 am	20131752 11-Dec-2013 9:53 am	20131753 11-Dec-2013 9:57 am
Lab Number:		1214754.6	1214754.7	1214754.8	1214754.9	1214754.10
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Oxadiazon	g/m³	-	-	-	-	< 0.00004
Oxyfluorfen	g/m³	-	-	-	-	< 0.00002
Paclobutrazol	g/m³	-	-	-	-	< 0.00004
Parathion-ethyl	g/m³	-	-	-	-	< 0.00004
Parathion-methyl	g/m³	-	-	-	-	< 0.00004
Pendimethalin	g/m³	-	-	-	-	< 0.00004
Permethrin	g/m³	-	-	-	-	< 0.00002
Pirimicarb	g/m³	-	-	-	-	< 0.00004
Pirimiphos-methyl	g/m³	-	-	-	-	< 0.00004
Prochloraz	g/m³	-	-	-	-	< 0.0002
Procymidone	g/m³	-	-	-	-	< 0.00004
Prometryn	g/m³	-	-	-	-	< 0.00002
Propachlor	g/m³	-	-	-	-	< 0.00004
Propanil	g/m³	-	-	-	-	< 0.0002
Propazine	g/m³	-	-	-	-	< 0.00002
Propiconazole	g/m³	-	-	-	-	< 0.00004
Pyriproxyfen	g/m³	-	-	-	-	< 0.00004
Quizalofop-ethyl	g/m³	-	-	-	-	< 0.00004
Simazine	g/m³	-	-	-	-	< 0.00004
Simetryn	g/m³	-	-	-	-	< 0.00004
Sulfentrazone	g/m³	-	-	-	-	< 0.0002
TCMTB [2-(thiocyanomethylthio) benzothiazole,Busan]	g/m³	-	-	-	-	< 0.00008
Tebuconazole	g/m³	-	-	-	-	< 0.00004
Terbacil	g/m³	-	-	-	-	< 0.00004
Terbufos	g/m³	-	-	-	-	< 0.00004
Terbumeton	g/m³	-	-	-	-	< 0.00004
Terbuthylazine	g/m³	-	-	-	-	< 0.00002
Terbuthylazine-desethyl	g/m³	-	-	-	-	< 0.00004
Terbutryn	g/m³	-	-	-	-	< 0.00004
Thiabendazole	g/m³	-	-	-	-	< 0.0002
Thiobencarb	g/m³	-	-	-	-	< 0.00004
Tolylfluanid	g/m³	-	-	-	-	< 0.00002
Triazophos	g/m³	-	-	-	-	< 0.00004
Trifluralin	g/m³	-	-	-	-	< 0.00004
Vinclozolin	g/m³	-	-	-	-	< 0.00004
Organochlorine Pesticides Trace in water, By Liq/Liq						
Aldrin	g/m³	-	-	-	-	< 0.000005
alpha-BHC	g/m³	-	-	-	-	< 0.000010
beta-BHC	g/m³	-	-	-	-	< 0.000010
delta-BHC	g/m³	-	-	-	-	< 0.000010
gamma-BHC (Lindane)	g/m³	-	-	-	-	< 0.000010
cis-Chlordane	g/m³	-	-	-	-	< 0.000005
trans-Chlordane	g/m³	-	-	-	-	< 0.000005
2,4'-DDD	g/m³	-	-	-	-	< 0.000010
4,4'-DDD	g/m³	-	-	-	-	< 0.000010
2,4'-DDE	g/m³	-	-	-	-	< 0.000010
4,4'-DDE	g/m³	-	-	-	-	< 0.000010
2,4'-DDT	g/m³	-	-	-	-	< 0.000010
4,4'-DDT	g/m³	-	-	-	-	< 0.000010
Dieldrin	g/m³	-	-	-	-	< 0.000005
Endosulfan I	g/m³	-	-	-	-	< 0.000010
Endosulfan II	g/m³	-	-	-	-	< 0.000010
Endosulfan sulfate	g/m³	-	-	-	-	< 0.000010

Sample Type: Aqueous						
Sample Name:		20131749 11-Dec-2013 12:21 pm	20131750 11-Dec-2013 11:05 am	20131751 11-Dec-2013 11:15 am	20131752 11-Dec-2013 9:53 am	20131753 11-Dec-2013 9:57 am
Lab Number:		1214754.6	1214754.7	1214754.8	1214754.9	1214754.10
Organochlorine Pesticides Trace in water, By Liq/Liq						
Endrin	g/m³	-	-	-	-	< 0.000005
Endrin aldehyde	g/m³	-	-	-	-	< 0.000005
Endrin ketone	g/m³	-	-	-	-	< 0.000010
Heptachlor	g/m³	-	-	-	-	< 0.000005
Heptachlor epoxide	g/m³	-	-	-	-	< 0.000005
Hexachlorobenzene	g/m³	-	-	-	-	< 0.00004
Methoxychlor	g/m³	-	-	-	-	< 0.000005
Total Chlordane [(cis+trans)*100/42]	g/m³	-	-	-	-	< 0.00002
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	-	-	< 0.000008
Acenaphthylene	g/m³	-	-	-	-	< 0.000008
Anthracene	g/m³	-	-	-	-	< 0.000008
Benzo[a]anthracene	g/m³	-	-	-	-	< 0.000008
Benzo[a]pyrene (BAP)	g/m³	-	-	-	-	< 0.000008
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	-	-	< 0.000008
Benzo[g,h,i]perylene	g/m³	-	-	-	-	< 0.000008
Benzo[k]fluoranthene	g/m³	-	-	-	-	< 0.000008
Chrysene	g/m³	-	-	-	-	< 0.000008
Dibenzo[a,h]anthracene	g/m³	-	-	-	-	< 0.000008
Fluoranthene	g/m³	-	-	-	-	< 0.000008
Fluorene	g/m³	-	-	-	-	< 0.000008
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	-	-	< 0.000008
Naphthalene	g/m³	-	-	-	-	< 0.00004
Phenanthrene	g/m³	-	-	-	-	< 0.000008
Pyrene	g/m³	-	-	-	-	< 0.000008
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	-	-	-	-	< 0.10
C10 - C14	g/m³	-	-	-	-	< 0.2
C15 - C36	g/m³	-	-	-	-	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	-	-	-	-	< 0.7

Sample Name:		20131754 11-Dec-2013 9:23 am	20131756 11-Dec-2013 10:27 am	20131757 11-Dec-2013 10:25 am	20131758 11-Dec-2013 1:16 pm	20131759 11-Dec-2013 1:06 pm
Lab Number:		1214754.11	1214754.12	1214754.13	1214754.14	1214754.15
Individual Tests						
pH	pH Units	7.4	7.4	7.4	7.0	7.2
Total Hardness	g/m³ as $CaCO_3$	81	75	75	59	74
Total Suspended Solids	g/m³	14	< 3	< 3	< 3	< 3
Dissolved Calcium	g/m³	21	19.0	19.7	15.9	19.1
Total Copper	g/m³	0.00150	< 0.00053	0.00056	< 0.00053	0.00066
Total Lead	g/m³	0.00085	< 0.00011	< 0.00011	< 0.00011	< 0.00011
Dissolved Magnesium	g/m³	7.1	6.7	6.3	4.7	6.4
Total Zinc	g/m³	0.0170	0.0080	0.0084	0.0016	0.0084
Total Nitrogen	g/m³	3.6	1.25	1.15	1.75	2.4
Nitrite-N	g/m³	0.04	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate-N	g/m³	3.1	1.09	1.05	1.29	2.3
Nitrate-N + Nitrite-N	g/m³	3.1	1.10	1.06	1.30	2.3
Total Kjeldahl Nitrogen (TKN)	g/m³	0.45	0.16	< 0.10	0.45	0.17
Dissolved Reactive Phosphorus	g/m³	0.052	0.018	0.029	0.015	0.033
Total Phosphorus	g/m³	0.079	0.071	0.039	0.027	0.036
Escherichia coli	cfu / 100mL	800 #1	1,200 #3	900 #3	150 #3	320 #3

Sample Type: Aqueous						
Sample Name:		20131760 11-Dec-2013 9:56 am	20131763 11-Dec-2013 9:34 am	20131764 11-Dec-2013 10:29 am	20131765 11-Dec-2013 11:31 am	20131766 11-Dec-2013 12:53 pm
Lab Number:		1214754.16	1214754.17	1214754.18	1214754.19	1214754.20
Individual Tests						
pH	pH Units	7.4	7.7	7.4	7.4	7.2
Total Hardness	g/m³ as $CaCO_3$	78	112	57	52	59
Total Suspended Solids	g/m³	69	21	< 3	< 3	< 3
Dissolved Calcium	g/m³	19.7	28	15.2	14.1	16.1
Total Copper	g/m³	0.0115	0.00124	< 0.00053	0.00061	< 0.00053
Total Lead	g/m³	0.0105	0.00110	0.00019	0.00012	< 0.00011
Dissolved Magnesium	g/m³	7.1	10.4	4.6	4.1	4.5
Total Zinc	g/m³	0.145	0.0182	0.0022	0.0014	< 0.0011
Total Nitrogen	g/m³	9.4	1.02	0.85	0.86	0.97
Nitrite-N	g/m³	< 0.02	0.05	< 0.02	< 0.02	< 0.02
Nitrate-N	g/m³	0.71	0.33	0.71	0.74	0.87
Nitrate-N + Nitrite-N	g/m³	0.73	0.39	0.71	0.74	0.87
Total Kjeldahl Nitrogen (TKN)	g/m³	8.7	0.64	0.14	0.12	< 0.10
Dissolved Reactive Phosphorus	g/m³	0.065	0.24	0.016	0.010	0.019
Total Phosphorus	g/m³	2.6	0.38	0.018	0.014	0.019
Escherichia coli	cfu / 100mL	1,000 #1	3,700 #3	280 #3	290 #3	140 #3
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Acetochlor	g/m³	-	-	< 0.00004	-	-
Alachlor	g/m³	-	-	< 0.00004	-	-
Atrazine	g/m³	-	-	< 0.00004	-	-
Atrazine-desethyl	g/m³	-	-	< 0.00004	-	-
Atrazine-desisopropyl	g/m³	-	-	< 0.00008	-	-
Azaconazole	g/m³	-	-	< 0.00002	-	-
Azinphos-methyl	g/m³	-	-	< 0.00008	-	-
Benalaxyl	g/m³	-	-	< 0.00002	-	-
Bitertanol	g/m³	-	-	< 0.00008	-	-
Bromacil	g/m³	-	-	< 0.00004	-	-
Bromopropylate	g/m³	-	-	< 0.00004	-	-
Butachlor	g/m³	-	-	< 0.00004	-	-
Captan	g/m³	-	-	< 0.00008	-	-
Carbaryl	g/m³	-	-	< 0.00004	-	-
Carbofenothion	g/m³	-	-	< 0.00004	-	-
Carbofuran	g/m³	-	-	< 0.00004	-	-
Chlorfluazuron	g/m³	-	-	< 0.00004	-	-
Chlorothalonil	g/m³	-	-	< 0.00004	-	-
Chlorpyrifos	g/m³	-	-	< 0.00004	-	-
Chlorpyrifos-methyl	g/m³	-	-	< 0.00004	-	-
Chlortoluron	g/m³	-	-	< 0.00008	-	-
Cyanazine	g/m³	-	-	< 0.00004	-	-
Cyfluthrin	g/m³	-	-	< 0.00004	-	-
Cyhalothrin	g/m³	-	-	< 0.00004	-	-
Cypermethrin	g/m³	-	-	< 0.00008	-	-
Deltamethrin	g/m³	-	-	< 0.00006	-	-
Diazinon	g/m³	-	-	< 0.00002	-	-
Dichlofluanid	g/m³	-	-	< 0.00004	-	-
Dichloran	g/m³	-	-	< 0.0002	-	-
Dichlorvos	g/m³	-	-	< 0.00008	-	-
Difenoconazole	g/m³	-	-	< 0.00008	-	-
Dimethoate	g/m³	-	-	< 0.00008	-	-
Diphenylamine	g/m³	-	-	< 0.00008	-	-
Diuron	g/m³	-	-	< 0.00004	-	-
Fenpropimorph	g/m³	-	-	< 0.00004	-	-
Fluazifop-butyl	g/m³	-	-	< 0.00004	-	-
Fluometuron	g/m³	-	-	< 0.00004	-	-

Sample Type: Aqueous						
Sample Name:		20131760 11-Dec-2013 9:56 am	20131763 11-Dec-2013 9:34 am	20131764 11-Dec-2013 10:29 am	20131765 11-Dec-2013 11:31 am	20131766 11-Dec-2013 12:53 pm
Lab Number:		1214754.16	1214754.17	1214754.18	1214754.19	1214754.20
OrganoNitrogen & Phosphorus pesticides, trace, liq/liq GCMS						
Flusilazole	g/m³	-	-	< 0.00004	-	-
Fluvalinate	g/m³	-	-	< 0.00004	-	-
Furalaxyl	g/m³	-	-	< 0.00002	-	-
Haloxyfop-methyl	g/m³	-	-	< 0.00004	-	-
Hexaconazole	g/m³	-	-	< 0.00004	-	-
Hexazinone	g/m³	-	-	< 0.00002	-	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m³	-	-	< 0.0002	-	-
Kresoxim-methyl	g/m³	-	-	< 0.00002	-	-
Linuron	g/m³	-	-	< 0.00005	-	-
Malathion	g/m³	-	-	< 0.00004	-	-
Metalaxyl	g/m³	-	-	< 0.00004	-	-
Metolachlor	g/m³	-	-	< 0.00004	-	-
Metribuzin	g/m³	-	-	< 0.00004	-	-
Molinate	g/m³	-	-	< 0.00008	-	-
Myclobutanil	g/m³	-	-	< 0.00004	-	-
Naled	g/m³	-	-	< 0.0002	-	-
Norflurazon	g/m³	-	-	< 0.00008	-	-
Oxadiazon	g/m³	-	-	< 0.00004	-	-
Oxyfluorfen	g/m³	-	-	< 0.00002	-	-
Paclobutrazol	g/m³	-	-	< 0.00004	-	-
Parathion-ethyl	g/m³	-	-	< 0.00004	-	-
Parathion-methyl	g/m³	-	-	< 0.00004	-	-
Pendimethalin	g/m³	-	-	< 0.00004	-	-
Permethrin	g/m³	-	-	< 0.00002	-	-
Pirimicarb	g/m³	-	-	< 0.00004	-	-
Pirimiphos-methyl	g/m³	-	-	< 0.00004	-	-
Prochloraz	g/m³	-	-	< 0.0002	-	-
Procymidone	g/m³	-	-	< 0.00004	-	-
Prometryn	g/m³	-	-	< 0.00002	-	-
Propachlor	g/m³	-	-	< 0.00004	-	-
Propanil	g/m³	-	-	< 0.0002	-	-
Propazine	g/m³	-	-	< 0.00002	-	-
Propiconazole	g/m³	-	-	< 0.00004	-	-
Pyriproxyfen	g/m³	-	-	< 0.00004	-	-
Quizalofop-ethyl	g/m³	-	-	< 0.00004	-	-
Simazine	g/m³	-	-	< 0.00004	-	-
Simetryn	g/m³	-	-	< 0.00004	-	-
Sulfentrazone	g/m³	-	-	< 0.0002	-	-
TCMTB [2-(thiocyanomethylthio) benzothiazole,Busan]	g/m³	-	-	< 0.00008	-	-
Tebuconazole	g/m³	-	-	< 0.00004	-	-
Terbacil	g/m³	-	-	< 0.00004	-	-
Terbufos	g/m³	-	-	< 0.00004	-	-
Terbumeton	g/m³	-	-	< 0.00004	-	-
Terbuthylazine	g/m³	-	-	< 0.00002	-	-
Terbuthylazine-desethyl	g/m³	-	-	< 0.00004	-	-
Terbutryn	g/m³	-	-	< 0.00004	-	-
Thiabendazole	g/m³	-	-	< 0.0002	-	-
Thiobencarb	g/m³	-	-	< 0.00004	-	-
Tolylfluanid	g/m³	-	-	< 0.00002	-	-
Triazophos	g/m³	-	-	< 0.00004	-	-
Trifluralin	g/m³	-	-	< 0.00004	-	-
Vinclozolin	g/m³	-	-	< 0.00004	-	-
Organochlorine Pesticides Trace in water, By Liq/Liq						

Sample Type: Aqueous						
Sample Name:		20131760 11-Dec-2013 9:56 am	20131763 11-Dec-2013 9:34 am	20131764 11-Dec-2013 10:29 am	20131765 11-Dec-2013 11:31 am	20131766 11-Dec-2013 12:53 pm
Lab Number:		1214754.16	1214754.17	1214754.18	1214754.19	1214754.20
Organochlorine Pesticides Trace in water, By Liq/Liq						
Aldrin	g/m³	-	-	< 0.000005	-	-
alpha-BHC	g/m³	-	-	< 0.000010	-	-
beta-BHC	g/m³	-	-	< 0.000010	-	-
delta-BHC	g/m³	-	-	< 0.000010	-	-
gamma-BHC (Lindane)	g/m³	-	-	< 0.000010	-	-
cis-Chlordane	g/m³	-	-	< 0.000005	-	-
trans-Chlordane	g/m³	-	-	< 0.000005	-	-
2,4'-DDD	g/m³	-	-	< 0.000010	-	-
4,4'-DDD	g/m³	-	-	< 0.000010	-	-
2,4'-DDE	g/m³	-	-	< 0.000010	-	-
4,4'-DDE	g/m³	-	-	< 0.000010	-	-
2,4'-DDT	g/m³	-	-	< 0.000010	-	-
4,4'-DDT	g/m³	-	-	< 0.000010	-	-
Dieldrin	g/m³	-	-	< 0.000005	-	-
Endosulfan I	g/m³	-	-	< 0.000010	-	-
Endosulfan II	g/m³	-	-	< 0.000010	-	-
Endosulfan sulfate	g/m³	-	-	< 0.000010	-	-
Endrin	g/m³	-	-	< 0.000005	-	-
Endrin aldehyde	g/m³	-	-	< 0.000005	-	-
Endrin ketone	g/m³	-	-	< 0.000010	-	-
Heptachlor	g/m³	-	-	< 0.000005	-	-
Heptachlor epoxide	g/m³	-	-	< 0.000005	-	-
Hexachlorobenzene	g/m³	-	-	< 0.00004	-	-
Methoxychlor	g/m³	-	-	< 0.000005	-	-
Total Chlordane [(cis+trans)*100/42]	g/m³	-	-	< 0.00002	-	-
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	< 0.000008	-	-
Acenaphthylene	g/m³	-	-	< 0.000008	-	-
Anthracene	g/m³	-	-	< 0.000008	-	-
Benzo[a]anthracene	g/m³	-	-	< 0.000008	-	-
Benzo[a]pyrene (BAP)	g/m³	-	-	< 0.000008	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	< 0.000008	-	-
Benzo[g,h,i]perylene	g/m³	-	-	< 0.000008	-	-
Benzo[k]fluoranthene	g/m³	-	-	< 0.000008	-	-
Chrysene	g/m³	-	-	< 0.000008	-	-
Dibenzo[a,h]anthracene	g/m³	-	-	< 0.000008	-	-
Fluoranthene	g/m³	-	-	< 0.000008	-	-
Fluorene	g/m³	-	-	< 0.000008	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	< 0.000008	-	-
Naphthalene	g/m³	-	-	< 0.00004	-	-
Phenanthrene	g/m³	-	-	< 0.000008	-	-
Pyrene	g/m³	-	-	< 0.000008	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	-	-	< 0.10	-	-
C10 - C14	g/m³	-	-	< 0.2	-	-
C15 - C36	g/m³	-	-	< 0.4	-	-
Total hydrocarbons (C7 - C36)	g/m³	-	-	< 0.7	-	-

Analyst's Comments

It has been noted that the method performance for Iprodione for ONOP analysis is not acceptable therefore we are unable to report this compound at this present time.

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this result with caution as the sample was > 8 °C on receipt at the lab. The sample is required to be less than 8 °C on receipt.

#2 It has been noted that the result for Dissolved Reactive Phosphorus was greater than that for Total Phosphorus, but within the analytical variation of these methods.

#3 Please interpret this result with caution as the sample was > 8 °C on receipt at the lab. The sample is required to be less than 8 °C on receipt.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Organochlorine/Organonitro&phosphorus Pest.s Trace in Water	Liquid / liquid extraction, GPC (if required), GC-MS analysis	-	10, 18
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis [KBIs:4736,2695]	-	10, 18
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	-	10, 18
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter. Performed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch.	-	1-20
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-20
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1-20
Total Phosphorus Digestion	Acid persulphate digestion.	-	1-20
pH	pH meter. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1-20
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-20
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 2540 D 22nd ed. 2012.	3 g/m³	1-20
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-20
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m³	1-20
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m³	1-20
Total Lead	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00011 g/m³	1-20
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-20
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.0011 g/m³	1-20
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N.	0.05 g/m³	1-20
Nitrite-N	Filtered sample from Christchurch. Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-20
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m³	1-20
Nitrate-N + Nitrite-N	Filtered sample from Christchurch. Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-20
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1-20
Dissolved Reactive Phosphorus	Filtered sample from Christchurch. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m³	1-20

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P B & E (modified from manual analysis) 22nd ed. 2012. Also modified to include the use of a reductant to eliminate interference from arsenic present in the sample. NWASCA, Water & soil Miscellaneous Publication No. 38, 1982.	0.004 g/m³	1-20
Escherichia coli	Membrane filtration, Count on mFC agar, Incubated at 44.5°C for 22 hours, MUG Confirmation Analysed at Hill Laboratories - Microbiology; 101c Waterloo Road, Hornby, Christchurch. APHA 9222 G, 22nd ed. 2012.	1 cfu / 100mL	1-20

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

APPENDIX 6

Hill Laboratories Results First Flush Event

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Marlborough District Council	**Lab No:**	1248867 SPv1
Contact:	Steffi Henkel	**Date Registered:**	17-Mar-2014
	C/- Marlborough DC Surface Water & Air Quality	**Date Reported:**	24-Mar-2014
	C/- Marlborough District Council	**Quote No:**	52686
	PO Box 443	**Order No:**	46354CVO
	BLENHEIM 7240	**Client Reference:**	Taylor Stormwater - First Flu
		Submitted By:	Peter Hamill

Sample Type: Aqueous

Sample Name:		20141180 - Pipe at STW-14 15-Mar-2014 10:06 pm	20141181 - Pipe at STW-15 15-Mar-2014 10:08 pm	20141182 - Pipe at STW-16 15-Mar-2014 9:51 pm	20141183 - Pipe at STW-17 15-Mar-2014 9:41 pm	20141184 - Pipe at STW-18 15-Mar-2014 10:35 pm
Lab Number:		1248867.1	1248867.2	1248867.3	1248867.4	1248867.5
pH	pH Units	7.0	6.9	7.0	7.4	6.8
Total Hardness	g/m³ as $CaCO_3$	20	18.9	24	43	13.1
Total Suspended Solids	g/m³	76	94	52	20	19
Dissolved Calcium	g/m³	6.0	5.7	7.1	11.9	4.1
Total Copper	g/m³	0.0164	0.0178	0.0079	0.0030	0.0177
Total Lead	g/m³	0.0098	0.0188	0.0112	0.0064	0.0080
Dissolved Magnesium	g/m³	1.23	1.15	1.63	3.2	0.72
Total Zinc	g/m³	0.49	0.43	0.35	0.43	0.29
Total Nitrogen	g/m³	6.1	2.9	5.8	1.06	0.91
Nitrite-N	g/m³	0.016	0.012	0.007	0.006	0.010
Nitrate-N	g/m³	0.44	0.43	0.59	0.60	0.32
Nitrate-N + Nitrite-N	g/m³	0.45	0.44	0.59	0.61	0.33
Total Kjeldahl Nitrogen (TKN)	g/m³	5.7	2.5	5.2	0.46	0.58
Dissolved Reactive Phosphorus	g/m³	0.32	0.122	0.096	0.047	0.129
Total Phosphorus	g/m³	1.45	1.08	0.30	0.27	0.196
Escherichia coli	cfu / 100mL	> 6,000 #1	10,000 #1	800 #1	1,500 #1	3,100
Escherichia coli	MPN / 100mL	> 2,420	> 2,420	1,120	1,046	> 2,420

a.k.a. Wither Stream at McKenzie Road

Sample Name:		20141185 - Pipe at STW-19 15-Mar-2014 11:00 pm	20141198 - Alabama Road Drain at ALA-5 15-Mar-2014 10:50 pm	20141199 - Mckenzie Stream upstream Sutherland Stm 15-Mar-2014 10:55 pm	20141200 - Murphys Creek at MUR-6 15-Mar-2014 9:25 pm	20141201 - Henry Street Stormwater 15-Mar-2014 10:00 pm
Lab Number:		1248867.6	1248867.7	1248867.8	1248867.9	1248867.10
pH	pH Units	6.9	6.8	6.8	7.1	6.9
Total Hardness	g/m³ as $CaCO_3$	9.9	12.4	9.7	42	16.1
Total Suspended Solids	g/m³	15	27	13	3	77
Dissolved Calcium	g/m³	3.0	3.9	2.9	12.1	4.9
Total Copper	g/m³	0.0027	0.0077	0.0035	0.00133	0.022
Total Lead	g/m³	0.00153	0.0052	0.0020	0.00054	0.0144
Dissolved Magnesium	g/m³	0.59	0.65	0.60	2.8	0.93
Total Zinc	g/m³	0.152	0.22	0.198	0.040	0.44
Total Nitrogen	g/m³	0.79	1.31	1.11	1.26	2.8
Nitrite-N	g/m³	0.009	0.008	0.010	0.003	0.011
Nitrate-N	g/m³	0.182	0.48	0.21	1.01	0.35
Nitrate-N + Nitrite-N	g/m³	0.192	0.49	0.22	1.01	0.36
Total Kjeldahl Nitrogen (TKN)	g/m³	0.60	0.83	0.89	0.25	2.4
Dissolved Reactive Phosphorus	g/m³	0.116	0.106	0.132	0.033	0.179

Sample Type: Aqueous						
Sample Name:		20141185 - Pipe at STW-19 15-Mar-2014 11:00 pm	20141198 - Alabama Road Drain at ALA-5 15-Mar-2014 10:50 pm	20141199 - Mckenzie Stream upstream Sutherland Stm 15-Mar-2014 10:55 pm	20141200 - Murphys Creek at MUR-6 15-Mar-2014 9:25 pm	20141201 - Henry Street Stormwater 15-Mar-2014 10:00 pm
Lab Number:		1248867.6	1248867.7	1248867.8	1248867.9	1248867.10
Total Phosphorus	g/m³	0.156	0.182	0.182	0.040	0.94
Escherichia coli	cfu / 100mL	3,400 #1	> 4,800 #1	6,800 #1	800 #1	> 4,200 #1
Escherichia coli	MPN / 100mL	> 2,420	> 2,420	> 2,420	1,046	> 2,420

Analyst's Comments

E.coli CFU results;
Please interpret this result with caution as the sample was > 24 hours old at the time of testing in the lab.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter. Performed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch.	-	1-10
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	1-10
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1-10
Total Phosphorus Digestion	Acid persulphate digestion.	-	1-10
pH	pH meter. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 4500-H+ B 22nd ed. 2012.	0.1 pH Units	1-10
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-10
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. Analysed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch. APHA 2540 D 22nd ed. 2012.	3 g/m³	1-10
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	1-10
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m³	1-10
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00053 g/m³	1-10
Total Lead	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.00011 g/m³	1-10
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-10
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012 / US EPA 200.8.	0.0011 g/m³	1-10
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N.	0.05 g/m³	1-10
Nitrite-N	Filtered sample from Christchurch. Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-10
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m³	1-10
Nitrate-N + Nitrite-N	Filtered sample from Christchurch. Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012.	0.002 g/m³	1-10
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1-10
Dissolved Reactive Phosphorus	Filtered sample from Christchurch. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m³	1-10
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P B & E (modified from manual analysis) 22nd ed. 2012. Also modified to include the use of a reductant to eliminate interference from arsenic present in the sample. NWASCA, Water & soil Miscellaneous Publication No. 38, 1982.	0.004 g/m³	1-10

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Escherichia coli	Membrane filtration, Count on mFC agar, Incubated at 44.5°C for 22 hours, MUG Confirmation Analysed at Hill Laboratories - Microbiology; 101c Waterloo Road, Hornby, Christchurch. APHA 9222 G, 22nd ed. 2012.	1 cfu / 100mL	1-10
Escherichia coli	MPN count using Colilert (Incubated at 35°C for 24 hours), or Colilert 18 (Incubated at 35°C for 18 hours), Analysed at Hill Laboratories - Microbiology; 101c Waterloo Road, Hornby, Christchurch. APHA 9223 B, 22nd ed. 2012, MIMM 11.A1.1, LAS Official test 1.1.1, 1.8.	1 MPN / 100mL	1-10

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

APPENDIX 7

Comparison of First Flush results with median results for the parameters analysed

Site ID		No. Samples	Calcium Dissolved (g/m3)	Copper Total (g/m3)	Dissolved Reactive Phosphorus (mg/L)	E. coli (n/100ml)	Hardness (g/m3 as CaCO3)	Lead Total (g/m3)	Magnesium Dissolved (g/m3)	Nitrate - Nitrogen (mg/L)	Nitrite - Nitrogen (g/m3)	Nitrite-Nitrate Nitrogen (g/m3)	Suspended Solids (mg/L)	Total Nitrogen (g/m3)	Total Phosphorus (g/m3)	Zinc - Total (g/m3)	pH
ST_DR_1	First flush	1	3.9	0.0077	0.106	4800	12.4	0.0052	0.65	0.48	0.008	0.49	27	1.31	0.182	0.22	6.8
	Median	12	23	0.001	0.041	650	85	0	6.8	3.8	0.003	3.8	3	4	0.046	0.015	7.55
ST_PI_7	First flush	1	4.9	0.022	0.179	4200	16.1	0.0144	0.93	0.35	0.011	0.36	77	2.8	0.94	0.44	6.9
	Median	1	4.9	0.022	0.179	4200	16.1	0.0144	0.93	0.35	0.011	0.36	77	2.8	0.94	0.44	6.9
ST_RIV_5	First flush	1	12.1	0.00133	0.033	800	42	0.00054	2.8	1.01	0.003	1.01	3	1.26	0.04	0.04	7.1
	Median	12	12.9	0.001	0.01	145	46	0	3.25	0.985	0.002	0.985	3	1.09	0.011	0.002	7.2
ST_PI_1	First flush	1	6	0.0164	0.32	6000	20	0.0098	1.23	0.44	0.016	0.45	76	6.1	1.45	0.49	7
	Median	12	18	0.001	0.034	750	68	0	5.6	0.92	0.002	0.925	3	1.125	0.043	0.017	7.5
ST_PI_2	First flush	1	5.7	0.0178	0.122	10000	18.9	0.0188	1.15	0.43	0.012	0.44	94	2.9	1.08	0.43	6.9
	Median	11	18.2	0.001	0.03	550	70	0	6.1	0.91	0.002	0.92	3	1.08	0.063	0.014	7.5
ST_PI_3	First flush	1	7.1	0.0079	0.096	800	24	0.0112	1.63	0.59	0.007	0.59	52	5.8	0.3	0.35	7
	Median	11	15.2	0.001	0.015	270	56	0	4.2	1.17	0.002	1.17	3	1.35	0.021	0.006	7.2
ST_PI_4	First flush	1	11.9	0.003	0.047	1500	43	0.0064	3.2	0.6	0.006	0.61	20	1.06	0.27	0.43	7.4
	Median	12	18.15	0.001	0.033	120	69	0	5.65	1.75	0.003	1.755	3	1.95	0.037	0.016	7.3
ST_PI_5	First flush	1	4.1	0.0177	0.129	3100	13.1	0.008	0.72	0.32	0.01	0.33	19	0.91	0.196	0.29	6.8
	Median	10	13.7	0.001	0.03	255	50	0.001	3.8	0.68	0.005	0.695	4.5	0.905	0.054	0.026	7.5
ST_PI_6	First flush	1	3	0.0027	0.116	3400	9.9	0.00153	0.59	0.182	0.009	0.192	15	0.79	0.156	0.152	6.9
	Median	1	3	0.0027	0.116	3400	9.9	0.00153	0.59	0.182	0.009	0.192	15	0.79	0.156	0.152	6.9
ST_EST_2	First flush	1	2.9	0.0035	0.132	6800	9.7	0.002	0.6	0.21	0.01	0.22	13	1.11	0.182	0.198	6.8
	Median	9	13	0.003	0.041	215	53	0.001	5.1	1.45	0.011	1.46	11	2.1	0.08	0.089	9.1